ENGINEERING NEWS

THE HUDSON SUSPENSION BRIDGE and New England Railway Co. furnish us further information in regard to their bridge which is to cross the Hudson river from Anthony's Nose, just above Peekskill on the east, to Fort Clinton on the west side. It will be in the form of a suspended girder, between iron towers, erected upon natural rock foundations on either side. There will be but a single span 1,625 ft. in length, and no piers, foundations or masonry will be built in the waterway. The bridge will carry a double track railway, and from its western terminus at Fort Clinton, tracks will be laid to Turner's Station, on the Erie road, while from the eastern end the track will extend to a point near the Connecticut State line. A tunnel is now being constructed through that portion of the dividing ridge lying west of the Hudson known as Bull Hill, by which grades on the lines of connecting roads coming east, will not exceed 37 ft. per mile. By means of this bridge the New England railroad systems will be directly connected with the great Western roads, and an all-rail route will be opened between New England and the coal fields. The New York & New England, the New York, Susquehanna & Western, and the Lehigh Valley railroad companies have already entered into contract with the Bridge Company, by which the former are to utilize the bridge and its connections for all of their traffic, that can be practically sent by that route, for a period of 50 years. The work, which will be finished within two years, is in charge of Gen. EDWARD W. SERRELL, Chief Engineer, and he is also President of the Bridge Company.

THE QUAKER BRIDGE DAM project is to be again opened to a public hearing on Nov. 19. At the meeting of the Aqueduct Commission, on Nov. 15, Chief Engineer CHURCH gave evidence to the effect that the great dam would impound more water and cost less money than the proposed earth dams on higher sites. At the same meeting Deputy Chief Engineer GEORGE S. RICE was put in charge of the repairs of all defective work on the aqueduct.

THE SUPREME COURT has put a final quietus on the monstrous doctrine that the Government had no recourse in law by which to procure the annulment of a patent once granted, procured by fraudulent means. That so many of the lower courts have given their adhesion to this view indicates a great void in the patent laws which should be filled by appropriate legislation. As the lower courts have held, any individual sued for infringement can plead fraud in obtaining the patent, and if he proves it, the patent is void as respects him; but the remaining 60-odd millions of the United States must still respect it until each for himself has obtained a similar decision. This is now disproved by the Supreme Court, but as the Government cannot be expected to take initial proceedings very often, it would seem as if an adverse decision against a patent in any private suit, should be taken as *prima facie* evidence of fraud and annul the patent, unless the patentee then establishes a successful defense in a suit brought for annulment. The Patent Office regulations expressly declare, that a patent once granted cannot be annulled by the office. The case against ALEX. GRAHAM BELL has a very ugly look. In Canada the patent is already annulled, but on different grounds.

A HEAVY WALL for the new 8th Regiment armory, 180 ft. long, 70 ft. high and 32 ins. thick at the bottom, blew down at 10 A. M. Sunday morning, in only a moderately high wind, which would otherwise have attracted no attention as in any way unusual. The wall was absolutely unsupported, its great thickness having been supposed to be sufficient to ensure stability. The mortar was somewhat green, but there does not seem any good reason for claiming that it was below a fair average of good brickwork. Assuming 125 lbs. per cu. ft., the moment of stability of a layer 1 ft. thick was 31,111 ft.-lbs., and assuming the center of pressure to have been 40 ft. above the surface (it was probably more) 780 lbs. or about 11.1 lbs. per sq. ft. would have been necessary to overturn it, corresponding under SMEATON'S formula for wind pressure to a "storm" of 50 miles per hour nearly (about 47 miles). It is doubtful if the wind was really so high, but allowing something for swaying and weak mortar, and for a higher centre of pressure than that assumed the pressure must have been at least 5 lbs., corresponding to a "strong to high wind" at 33 or 34 miles per hour. This seems to indicate that SMEATON'S formula is about right.

THE CENTRAL URUGUAY NORTHERN EXTENSION RAILWAY Co., capital stock $5,000,000, has been formed in England as an offshoot of the Central Uruguay Railway of Monte Video, for the purpose of acquiring and carrying out the concession granted by the Government of the Republic of Uruguay for a railway between Paso de los Toros and Rivera (Santa Ana) a distance of about 180 miles. It is a continuation of the Central Uruguay line, and will give direct communication between Monte Video and Brazil. By the concession the Government guarantees, for the term of 40 years, interest at the rate of 7 per cent. per annum on a capital of $25,000 for each kilométre constructed. This guarantee will be sufficient, it is estimated, after providing for the annual charge for the debenture stock of the company, to pay 7 per cent. upon the share capital. A considerable frontier trade now exists between the Uruguayan Republic and Brazil, which, it is believed, the provision of railway facilities will largely stimulate. The direction of the new enterprise will be the same as that of the parent company. J. LIVESEY & SON are the engineers, and ROBERT CRAWFORD has the contract for the complete construction and equipment of the line.

AN INDEPENDENT OIL-PIPE LINE is to be built from the lower oil-fields to Philadelphia, according to rumor. The Globe Refining Co. of Pittsburg having purchased the plant of the Chester Oil Co., near Philadelphia, this pipe-line becomes necessary to free them from the pressure of the Standard Oil Co.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was the derailment of a special (that most unlucky class of trains) on the Buena Vista & Americus line of the Georgia Central, near Ellaville, Ga., on Nov. 7. The train was made up of freight and passenger cars; one of the freight cars left the track and the two passenger cars behind it were overturned and wrecked. Four persons were killed and 12 injured, some fatally.——Another excursion train heavily loaded on the Central of New Jersey came very near a bad wreck by collision with an engine, but a few bruises and two wrecked engines were the only result.—— A rear collision between freight trains occurred Nov. 8, on the south branch of the Denver & Rio Grande near Graneros, Col. A wheel broke on a car of a Fort Worth freight train and the train was brought to a sudden stop, extinguishing by the jar every light on the train, including the red lights on the rear end of the caboose. The men say that an attempt was made to light a lantern and to send a man back to flag a following Denver & Rio Grande train, but it was right upon the other train when the man started back to signal it: the train was a double header and both engines and several cars were wrecked. One man was killed and 2 injured. ——On Nov. 11, the track of the Louisville, New Orleans & Texas Pacific was wrecked for a distance of 5 miles north of Yckena, Miss. Just after leaving the station one of the cars of a freight train jumped the track and ran 5 miles before the accident was discovered. The flanges of the wheels broke loose nearly all fish-plates on one side of the rails, and damaged the track to such an extent that no train could pass until repairs had been made.

BRIDGE ACCIDENTS are reported as follows: A trestle about 100 ft. long on the West Shore road near Alabama, N. Y. was burned Nov. 5.——On Nov. 9 a trestle nearly 25 ft. high, over French creek, near Jasper, Ala., on the Kansas city, Memphis & Birmingham road, gave way under a cattle train, and three cars and a caboose went into the creek. One man was killed and four injured.——On Nov. 10 the highway bridge over East Haverhill St., at Lawrence Mass., collapsed. No passengers were on it at the time.——On Nov. 13, while a freight train on the Newark & New York branch of the New Jersey Central Railroad was passing over the bridge at West Bergen, N. J., the bridge collapsed, wrecking the entire train. The bridge was an old one of wretched design, according to modern standards and there are a number of others on the line likely to share the same fate if not removed in time.

A WASHOUT occurred on the Erie road, near Tonawanda, N. Y., Nov. 10. The Lehigh Valley way freight for Buffalo was going at a high rate of speed, when the tracks slid out and ditched 14 cars. The engine passed over and remained on the track. The engineer uncoupled and started for Buffalo, but had gone only a few rods when a second washout occurred, ditching the engine also. The cars were all badly broken up. The accident was caused by the recent heavy rains.

THE BOTTOM of the city reservoir at Roanoke, Va. caved in Nov. 10, causing a loss of $15,000. The reservoir is on Mill mountain and it is supposed the roof of the caverns underneath gave way.

THE STOVE in the ladies' toilet room of a Pullman car on a Pennsylvania R. R. train, Nov. 13, set fire to the car, and about half the car was burned before the flames were extinguished. Some of the passengers lost clothing and property. The porter is said to have used the fire extinguisher with good effect.—— A north bound passenger train on the Richmond & Danville was derailed by a broken wheel near Toccoa, Ga., Nov. 12, all of the seven cars went over the bank and all were destroyed by fire. Nobody was seriously injured.

PHILEDELPHIA PUBLIC WORKS are apparently to be "boomed" next year. The appropriation for the Highway Bureau last year amounted to $970,000. But $1,300,000 and a possible $2,000,000 are the figures talked of now. The principal item will be $500,000 for street paving, an item of sore need in that city.

THE THIRD AVENUE RAILWAY CO., New York City, still intends to do away with horses as motive power, and at the annual meeting this week it was stated that the cable line will be completed from 125th St. to the City Hall within a year. The consent of the owners of more than half the assessed real estate along the road has already been obtained. The company's case is now before the Court of Appeals, and a decision is expected this month. If favorable, work will be commenced at once; if unfavorable, the company will apply to the State authorities for the necessary permission.

THE PHILADELPHIA & NORTHEASTERN ELEVATED RAILWAY bill passed the Common Council of Philadelphia on Nov. 13. The structure is to be of steel or iron, with a least elevation of 15 ft. above street surface and 22 ft. above railway tracks crossed. The fare is fixed at 5 cents from 5 to 9 A. M. and 4 to 7.30 P. M. and 10 cents at other hours, and the company is to pay quarterly 1 per cent. of its gross receipts into the City Treasury. A bond of $100,000 secures the city against damage during construction, and another bond of $1,000,000 is filed to secure property holders and tenants along the line.

THE NEW ORLEANS BELT RAILROAD QUESTION is being again agitated, and Mr. E. L. CORTHELL, C. E., was lately in that city on business connected with it. It would be designed to connect existing lines for the exchange of freight and facilitation of traffic.

NEW STEEL ORDNANCE BIDS are invited by the Ordnance and Fortification Board for 25 sets of forgings for 3.2-in. guns; for one 12-in. breech-loading rifle; 27 sets for 12-in. mortars, and complete sets of forgings for 8-in., 10-in., and 12-in. guns with breech mechanism etc. The total estimated cost is $1,455,000 and the bids per pound in each case for the gun forgings are to be opened Dec. 20, for the manufacture of mortars on Dec. 15 and for the 3.2-in. and 12-in. forgings on Dec. 11.

THE PACIFIC CABLE PROJECT is to be considered at a conference to be held in London, on Nov. 22. All the leading commercial and shipping houses interested in Canada and Australia are invited to be present. The necessary imperial and coloonil guarantee of $375,000 per annum is already practically assured.

The Proper Relation to Each Other of the Sections of Railway Wheels and Rails.

[Preliminary Report of the Commitee on this subject to the American Society of Civil Engineers.]

(*Continued from page 361*).

SHARP FLANGES A NORMAL MODE OF FAILURE.

Your Committee deem it appropriate to here point out that a certain proportion of sharp flanges is a perfectly normal and inevitable result from the conditions, and in no case presumptive evident of any defect in proportion of either rail or wheel, even without considering the high relative mileage of such wheels before determined, nor does it appear to be a defect in its nature curable by any mode of wear or by any radius of rail corner.

Let us suppose a wheel running only on a perfectly straight road, and running so true that it has no tendency to run to or away from flange. Let us make both fillet and rail corner of large and identical radius, so that no question of the form of rail can come in. Let us suppose hat there is no extra abrading friction results from the fillet contact *a c*, Fig. 4, but only normal rolling wear.

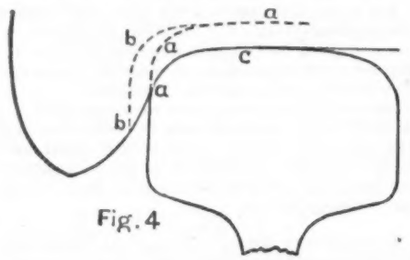


Fig. 4

The result of long service under such impossibly favorable conditions will ultimately be the worn tread *a a a*—which gives a sharp flange. Let there be the slightest tendency to run to flange, and we have the more pronounced case *b b a*. Only in case of tendency to run away from flange will the flange sections remain unmutilated.

Again, suppose the curvature to be so sharp, or the truck so out of square, that before any considerable tread wear results the flange is worn, and let the fillet and corner radii be large and identical as before. We then have the worn tread *c d d*, Fig. 5, and the large corner radius cannot help it.

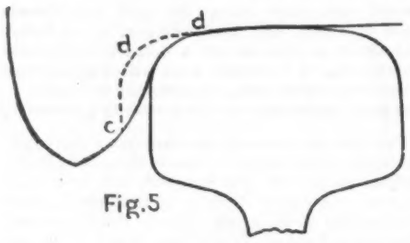


Fig. 5

Again, let us suppose as even as possible distribution of the wear between fillet and flange, so that the wear is on a parallel line with the original tread. We still have the straight flange wear *A A*, Fig. 6, and resulting thin flange.

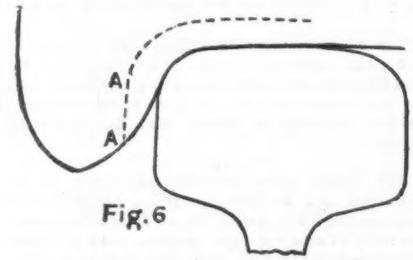


Fig. 6

It is therefore no cause for surprise or alarm that when worn out wheels only are considered, excluding wheels which "die young" from defects, the proportion of sharp flanged wheels is large. If all wheels ran perfectly true, the proportion of wheels which showed a decided tendency to sharp flange would be very large, if the above reasoning be correct, approximating to all of them. If we assume, however, as our reasoning indicates, that practically all axles have more or less tendency to run to flange on one side, this relieves half the wheels of a tendency to flange-wear and aggravates it in the other half, nd we should expect with more confidence to find a full alf the wheels, and no more, suffering from flange-wear, whatever the radius of fillet and rail. The statistics herewith presented indicate strongly that when wheels which fail from legitimate wear only are considered, excluding failures from specific defect, this is in fact the case, but the surprising and significant fact is that the life of the flange-worn wheels does not suffer thereby.

Our investigations so far indicate:

First.—That a tendency to sharp flange is a natural phenomenon, which must exist and does exist in all perfect and perfectly running wheels, and is not eliminated by any form of rail or wheel.

Second.—That imperfections of diameter of wheels or of trucks, or both, give a tendency to run to one rail or the other to nearly all axles, relieving half the wheels of flange-wear tendency, and aggravating that of the other half.

Third.—That the quality of the wheel then has an enormous effect on the number of sharp flanges, causing many more when the fillet-chill is softer than the tread.

Fourth.—That when the wheel is sound and the quality even, about half the wheels get sharp flanges, while this proportion is reduced as the number of special defects increases, which cut short the life of the wheel before it is worn out.

Fifth.—That wheels which fail from flange-wear are among the most durable of all wheels, if not the most durable, approximating to, if not exceeding, the life of those which fail from long-continued tread wear only, without developing other defect; so that no appreciable money loss results from wheels running to flange instead of failing from tread wear only.

It remains to be seen, however, what form of rail does most to prolong the life of wheels which run to flange, and what form of flange does most to prolong the life of rails. Considerable statistical light may be thrown on this question from various technical observations of rail-wear on curves and tangents which have been made.

RAIL-WEAR AS MODIFIED BY FLANGE CONTACT.

In the year 1877 Mr. A. M. WELLINGTON, of your Committee, made an investigation of the comparative life of steel rails on the Atlantic and Great Western (New York Pennsylvania and Ohio) Railroad, the results of which were reported in a paper published in the pamphlet Report of the Road-masters' Meeting of 1878, and also in the *Railroad Gazette* of 1877. These investigations were undertaken for the primary purpose of determining the comparative wear of rails of various makes, and extended to rails of all makes on all kinds of alignment. They were made by determining the original weights of the rail by the carload invoices, removing the rails from the track and weighing them, taking an accurate section by a machine made for the purpose, determining the tonnage which passed over them, and so determining the loss per yard in pounds per 10,000,000 tons of duty. In all, 145 steel rails were thus computed. The full tabular results are not reproduced here, since they can be easily referred to.

In 1879-80 a similar investigation was made on the Pennsylvania Railroad by Dr. CHARLES B. DUDLEY (Transactions Am. Inst. M. E., 1880), 64 rails having been used, 16 from level tangents, 16 from level curves, 16 from grade tangents and 16 from grade curves. Half of the rails from curves were taken from the outside rail and half from the inside rail, and half of each set were selected from the faster wearing rails and half from the slower wearing.

In neither of these papers was the possibility that the rate of wear on curves might vary with the age, and hence, form of the rails given any consideration, or even alluded to. Apparently the possibility did not occur to either of those conducting the investigation. Both papers appear to contain conclusive evidence that such is the case, however, especially when considered together; all the more conclusive because it was unconsciously collected and embodied in tables.

Your Committee know of no other investigations of the kind in this country or in England. Some have been made in Germany, which it has not appeared necessary to refer to further in this report nor to study in detail, since your Committee has reason to believe that they correspond in substance with the facts here presented.

The law of rail-wear on the outside of curves is well known. However sharp cornered the rail originally, the flange, in time, beds into it deeply, and wears it almost to its exact form, as shown in Fig. 11. The newer the rails, the less the area of contact surfaces. As the rail wears, the contact area becomes greater, until finally it includes nearly the whole flange.

Under these circumstances your Committee cannot but regard it as highly significant to find in these records what certainly appears to be absolute evidence that, while the rail is new and the contact areas small, the rate of rail-wear on curves is very slow, but increases in a rapid geometric ratio (approximating to the square of the age in tons, apparently), as the rails become more worn. Since action and reaction are equal, a more rapid rail-wear implies also a more rapid flange-wear, so that if the above fact be admitted it necessarily implies that to imitate in the beginning the conditions which finally obtain from wear on the outside of curves, by making the rail corner and fillet fit each other from *A* to *B* in Fig. 2, is the reverse of good practice.

The following Tables, 8 and 9, give in part the evidence which these tests have to shed. There were these differences between the tests:

TABLE 8.

TANGENT RAIL-WEAR OBSERVATIONS ON NEW YORK, PENNSYLVANIA & OHIO (Atlantic & Great Western) R. R., 1877.

Rails of Least Age		Rails of Greatest Age	
Tonnage	Wear in lbs. per 10,000,000 tons	Tonnage	Wear in lbs. per 10,000,000 tons
5 526 580	1.24	26 441 000	0.85
6 000 400	1.30	24 788 000	0.85
11 819 800	0.16	21 050 800	1.05
11 250 800	0.66	20 574 800	0.82
14 364 000	1.63	20 574 800	0.44
14 364 000	1.02	20 574 800	1.11
14 364 000	0.63	19 831 000	0.51
14 364 000	0.90	17 433 300	1.09
14 364 000	0.56		
14 364 000	1.84		
Average	1.084	Average	0.84

First—The Pennsylvania tests were made on much older rails, the newest being older in tonnage life than the oldest of the Atlantic and Great Western rails. All the curve rails, without exception, were badly flange-worn.

Second—The Pennsylvania tonnage had a much less proportion of engines and larger proportion of cars than the Atlantic and Great Western, as did also the tonnage over the Pennsylvania level rails than the tonnage over the grade rails. This greatly affected the rate of tangent wear and curve wear alike, per million tons, making it necessary for comparative purposes to equate the observed curve wear of the Pennsylvania for a uniform tangent wear with the Atlantic and Great Western, on the assumption that the causes, whatever they were which caused the tangent wear to vary, caused the curve wear to vary correspondingly. The table contains internal evidence that any error in this assumption must have been very small, not affecting the very marked contrast in wear of rails at different ages appreciably.

Third—The Pennsylvania tests included a much smaller range of curvature, covering only 2, 3, 4 and 5° curves.

It will be seen in the following Table 9, that without a single exception which can be called such, the effect of age to increase the outside rail-wear is very marked indeed. That it was the change in the form of the rail and not the wearing through of the skin or other cause, which caused this difference of wear, is clearly indicated by the following Table 8, showing that the tangent rail-wear was more rapid in the newer than in the older rails.

Each of these observations includes the average of 2 to 6 contiguous rails, separately weighted and sectioned to determine loss. Here there is no sign whatever of any tendency to increased wear with age or tonnage duty, but the direct contrary, as was still more markedly the case with the Pennsylvania rails, a fact to be explained largely by the earlier rails being of far better quality than the latter ones. This same difference, presumably, runs through the following statistics in curve rail-wear, and if so, would indicate that the striking increase of curve rail-wear with age which appears, would be considerably greater if the effect of the better quality of the older rails could be eliminated.

TABLE 9.

RAIL-WEAR OF THE OUTSIDE RAIL OF VARIOUS CURVES AT VARIOUS TONNAGE AGES, as deduced from tests on the New York, Pennsylvania & Ohio (Atlantic & Great Western) R. R., showing the increasing rate of wear with age.

Corresponding figures from the Pennsylvania tests, equated to correspond to the same rate of tangent wear (0.92 lbs. per ton 10,000,000 tons duty) added for comparison, and to extend the range of the table. (In both sets of tests the tangent rails showed the slowest wear for the greatest ages, or the reverse of the curves).

Curve	Age of Rails in Tons.	Lbs. per yd. per 10,000,000 Tons.
1°	1,932,200	1.18
"	14,364,000	0.90
"	14,364,000	0.84
Average, newer rails	10,220,100	0.97
1°	17,433,300	1.36
"	20,574,800	1.21
"	23,920,000	1.16
Average, older rails	20,642,700	1.24
2° (P. R. R. level, ave. of 4 rails)	57,512,400	1.61
3°	11,250,800	1.09
"	11,250,800	1.60
"	11,819,800	0.34
Average, newer rails	11,440,500	1.04

3°	14,364,000	1.40
"	14,516,100	1.44
"	14,364,000	2.37
"	21,050,800	1.40
Average, older rails	16,073,700	1.66
3° (P. R.R. level, ave. of 2 rails)	46,908,800	2.75
4°	11,950,000	0.81
"	23,136,000	2.42
"	35,910,000	1.74
Average	23,665,300	1.66
4° (P.R.R.grade,slower wearing)	32,428,614	2.23
4° (P. R. R. level, 2 rails)	45,071,000	2.67
5°	14,364,000	3.13
"	14,364,000	3.13
"	21,814,000	1.99
Average	16,847,300	2.43
5° (P.R.R.grade, av. of 8 rails	40,129,300	2.30
6°	6,000,400	1.48
"	11,514,000	1.52
"	14,364,000	2.42
Average	10,626,100	1.81
8°	5,526,530	2.62
"	5,526,530	2.91
"	5,526,530	3.80
Average, newer rails	5,526,530	3.11
8°	15,429,300	3.16
"	18,433,300	4.75
Average, older rails	17,431,300	3.95
12°	6,000,400	6.92
16°	6,000,400	13.00

NOTE.—The Pennsylvania observed rail-wear, owing either to difference in quality of rails, or to the longer trains and less proportion of engine tonnage, or both (probably chiefly the latter), showed a much lower rate of tangent rail-wear per million tons on the low grades than on the high grades,and even on the high grades than on the Atlantic and Great Western. As the causes which modified the tangent wear would modify the curve wear *pro rata*, the curve wear was equated for the above comparative purposes as follows:

	Tangent Wear per 10,000,000 tons.		Ratio.
Atlantic & Great Western	0.92	lbs.	1.00
Pennsylvania level grades,average	0.3845	"	$\frac{1}{2.39}$
" high grade,slow wear	0.540	"	$\frac{1}{1.70}$
" " fast wear	0.881	"	$\frac{1}{1.044}$
" " average	0.700	"	$\frac{1}{1.314}$

That these assumptions (as to equating for a uniform tangent wear) lead to correct results, is indicated in a measure by comparing the 4 slower wearing and 4 faster wearing grade curve rails of the Pennsylvania tests, the observed actual wear for which was 1.291 lbs. and 2.217 lbs. When multiplied by the above ratios they give almost precisely the same equated ratio as given above.

The inside rails corresponding to the above outside rails show no sign of increase in rate of wear from age in either series of tests.

TABLE 10.

RAIL-WEAR OBSERVATIONS on the New York, Pennsylvania & Ohio (Atlantic and Great Western) Railroad, reclassified from Table 9, according to Age of Rails when observed.

[The wear is per 10,000,000 tons duty; the duty given is the average of all rails observed].

	Rails of Least Age.		Rails of gr'at'st age		General Average.	Excess for c'rve	Excess per degree.
	Million tons.	Lbs. wear.	Million tons.	Lbs. wear			
Tangent	12.1	1.084	20.0	0.84	1.00	.....	.....
1°	10.0	0.97	20.5	1.24	1.10	.10	.100
3°	11.4	1.04	16.1	1.66	1.40	.40	.133
4°	12.0	0.81	29.5	2.08	1.06	.66	.165
5°	14.4	2.65	21.8	1.99	2.43	1.43	.286
6°	6.0	1.48	13.0	1.97	1.81	.81	.135
8°	5.5	3.11	16.4	3.95	3.45	2.45	.306
Average	9.9	1.68	19.6	2.15			
12°	6.0	6.92	.....	.....	6.92	5.92	.492
16°	.60	13.00	.....	.....	13.00	12.00	.750

	Least Age.		Most Age.	
	Million tons.	Lbs.	Million tons.	Lbs.
Average total wear per 10,000,000 tons on all curves 1 to 8 degrees, inclusive	9.9	1.68	19.6	2.15
Deduct tangent wear	12.1	1.08	20.0	0.84
Excess of wear per 1,000,000 tons due to same curvature at different ages	9.9	0.60	19.6	1.31

The concluding lines of Table 10 indicate that the wear was as nearly as may be double as fast at double the age.

The conclusions reached above are confirmed independently by another method of analyzing these rail-wear tests. So far we have compared only rails of different age on curves of the same degree. If we compare the average of the rails of different degrees with each other, we are led to substantially the same conclusion by another road.

The slippage per 100 ft. of track due to curvature is directly as the degree of curvature, and hence the resistance and the rail-wear should be, other things being equal. If, however, we take a lot of rails of substantially the same tonnage age but on widely different degrees of curvature and compare them together, it is obvious that the rails on the sharper curves will have sustained a much larger proportion of their mileage life, have been much more worn to the form of the flange, and hence, if it be a fact that the rate of abrasion increases with such wear, the older rails should show a much more rapid rate of abrasion.

The Pennsylvania tests are too limited in range of curvature, and the rails were all too nearly worn out, to admit of comparison on this basis, but the Atlantic & Great Western were all comparatively new and about the same age (those on the sharpest curves the youngest), and it was found that with observations taken under these conditions the excess of curve rail-wear was as the square of the degree of curvature. In his report of these tests (p. 145) Mr. WELLINGTON stated:

"It is evident from the table that the wear increased considerably faster than the degree of curvature, and it was found that the following empirical formula *fitted the observed facts* (Italics as quoted) as nearly as any which could be devised, viz:

"*Extra wear due to curvature in pounds per yard per 10-000,000 tons duty on a d degree curve* $= 0.03d^2$.

And hence,

"*Total wear of rails on a d degree curve in pounds per yard per 10,000,000 tons duty* $= 1 + 0.03d^2$.

"In the two following lines is given the wear according to this formula, directly opposite the average observed wear, and the closeness with which the two correspond can be seen.

Observed rate of rail wear in pound, per 10,000,000 tons duty, on a curve of

1°	3°	4°	5°	6°	8°	12°	16°
.10	.40	.36	1.43	.81	2.45	5.92	12.00

Computed rate by formula

.03	.27	.64	.75	1.05	1.92	4.32	7.68

"It is not pretended that this formula is strictly correct, even in theory, but several theoretical considerations indicate that it may be nearly so."

If we remember in connection with these figures (1) that they included both inside and outside rails, only the latter showing a tendency to flange wear; (2) that the rails on the sharper curves were much younger than on the easier ones, so that the full contrast had not developed, and (3) that the rate of tangent rail-wear of the same rails seemed rather to decrease with age, these figures seem to your Committee to be strong evidence that the rate of rail-wear grows very materially greater as the rail corner is rounded off to fit the fillet of the flange.

Theory indicates that this should be so, because the flange has a longer bearing on the side of the rail, as does also the following additional practical evidence: The old Pennsylvania standard rail was sharp-cornered, with a 5-16 inch radius; the new one has a $\frac{5}{8}$-inch radius. These two rails have been examined in parallel tangent tracks by members of your Committee, the old pattern rails being 11 years old and the new pattern only one year old. The old pattern has lost considerably in height, but the rail corner is even sharper than when new, and there is no sign of flange wear. The new pattern is already badly flange-worn for fully $\frac{5}{8}$-inch below the top of the rail,the appearance being that as much metal has been lost off the corner of the rail as on top, and the first impression conveyed being that the track is wide of gauge. It was found on trial that this was not at all the case, however, but that the gauge was full.

Some of your Committee have also observed that the same thing is true of the round-cornered Lehigh Valley rail. Wherever this rail is laid the rail is worn far down the side as if it were the outside rail of a curve, whether on curves or tangents.

The apparent evidence of the experimental records is that the radius of rail-corner which results in least abrasion to the rail, and hence presumably of wheel, is not over 5-16 or $\frac{3}{8}$-inch, the original corner radius of the A. & G. W. rails tested, and that as the radius becomes larger from wear, and the fillet and flange contact larger, the rate of wear rapidly increases.

It is also a fact so well known [that your Committee do not deem it necessary to establish it by further evidence than Figs. 32 and 33, that it is only the outside rails of curves which wear to a larger radius to fit the fillet. Whatever the original form, all inside and tangent rails wear in time to a very sharp corner. As an average of the whole United States, curves constitute about 25 per cent. of the whole mileage, and hence outside rails about one-eighth. To establish precisely what does occur, Mr. THOMAS RODD, of your Committee, caused the accompanying sections of worn rails to be taken (published in ENGINEERING NEWS, Oct. 8, 1887,) as explained in the Appendix.

Similarly the fillet radius of wheels almost invariably increases with wear, even in flange-worn wheels (see Fig. 3), and so far as your Committee can ascertain, practically never decreases, even in flange-worn wheels. With rare exceptions the fillet radius becomes $\frac{3}{4}$-inch or more.

That the radii of rails and wheels finally become from wear quite divergent does not necessarily imply that they should be made so in the first place, but it does appear to imply that no difference of corner radius can have much effect to diminish flange wear.

So far, your Committee have considered this question purely from the light of experience, with no attempt to determine what theory indicates. It would be improper to draw any conclusions in so important a matter, however, without considering it from a theoretical point of view, which we now proceed to do.

(CONCLUDED NEXT WEEK.)

Abstracts from an Engineer's Note Books.

Voids in Masonry.—The enlargement of the Erie Canal, with 18 double locks and a long aqueduct in the first 14 miles north of Albany, afforded unusually favorable opportunities for determining the ratio of voids to the total volumes in various classes of masonry.

The stone used in this work was quarried and cut 30 to 40 miles up the canal and transported to the new locks near Cohoes. On the arrival of each boat load each stone was carefully measured, as the payments were made under the contract on the returns of the engineer, and at the end of the building season all work done and the amount of stone remaining on hand was also accurately measured. These returns make the basis of the following notes:

The cut-stones, forming two-fifths of the mass, were cut to lay to $\frac{1}{4}$ in. joints, and the remaining three-fifths were large rectangular blocks with beds and joints not exceeding one inch as laid, excepting occasional "wantages" at the corners. These voids were filled with small spalls and hydraulic cement mortar. One barrel of hydraulic cement of 300 lbs., and measuring 4.7 cu. ft., was mixed with one and one-half barrels of rather fine sand, and this mixture formed 6.59 cu. ft. of mortar, which laid up 3.60 cu. yds. of front and rear masonry of the locks. The percentages of voids found, for the several seasons and amounts of masonry were as follows:

Season of	Lock	Stone laid cu.yds.	Masonry l'd cu.yds.	Voids per cent. of
1840	Nos. 4,5,6	5,515	6,300	14.2
1841	"	3,505	4,004	14.2
1840	Nos. 8, 13	3,148	3,591	14.1
"	No. 10	1,764	1,970	11.7
"	No. 15	1,830	2,030	11.0
	Total=15,762		Ave. = 13.5	

The backing in locks Nos. 10 and 15 was closer dressed and the voids were consequently less.

Masonry per Barrel of Cement.—The cubic yards of masonry laid with one barrel of hydraulic cement mixed with one and one-half barrels of rather fine sand, were as follows on the Erie enlargement referred to:—

	per barrel of cement. cu. yds.
Lock-walls, face and rear	3.6
Aqueduct Spandrill	2.0
Rubble Masonry	1.2
Aqueduct Abutments	1.8
" Arches	3.0
" Piers	2.4
Concrete	1.0

Volume Laid per Mason.—The cubic yards of masonry laid per mason per day, with 2 tenders to each mason to aid in laying stone and 1 stone cutter to trim the block. was as follows:—

Date.	How and where laid.	Volume cu. yds.	Days work masons	Av. per day per mason cu. yds.
1839	By crane on 6 locks	5,303	863	6.14
"	By derrick on 1 lock	1,455	231	6.30
"	By railway, 3 locks	3,062	356	8.70
1840	By cranes, 9 "	10,347	2,307	4.40*
"	By derricks,3 "	5,084	895	5.86*
"	By railways,2 "	2,943	——	4.14*
1841	By cranes, 4 "	4,616	840	5.50
1840	On 25 Aq.t Piers	2,197	366	6.00
1841	" "	1,648	283	5.83
"	On 25 Arches	2,462	275	8.95
"	On 25 Spandrills	1,841	223	8.26

* These averages included the stone cutters on the walls not separated from the mason gang in these cases.

RAILROADS IN SIBERIA are to be built by "a powerful American syndicate" says a despatch from St. Petersburg. Besides a large subsidy the Government is to pay 4,000,000 roubles ($2,320,000 gold) annually for the transportation of mails and convicts.

How To Build Earthen Dams With Perfect Safety.

The subject of reservoir and dam construction is an exceedingly live issue at the present time, and as we have had considerable to say upon the subject of masonry and rock-fill dams, we now propose to tell something of earthen dams, their safe construction and their general causes of failure. For the matter which follows we are indebted largely to the courtesy and the note-books of the Hon. WM. J. MCALPINE, whose voluminous notes cover over 40 years of experience in the construction of reservoirs and dams on the Erie Canal and elsewhere, and a careful study and criticism of similar works in other countries.

Dams for reservoirs, canals, etc., are made of earth, stone, or wood. Memoranda kept during many years relating to the causes of failures in dams, as far as could be ascertained, fix the relative order of failure about as follows: For one earthen dam destroyed, there were 4 stone dams and 10 of wood carried away. These notes, of course include dams of every class where failure was noted, ranging from the most important to the most simple in construction and use.

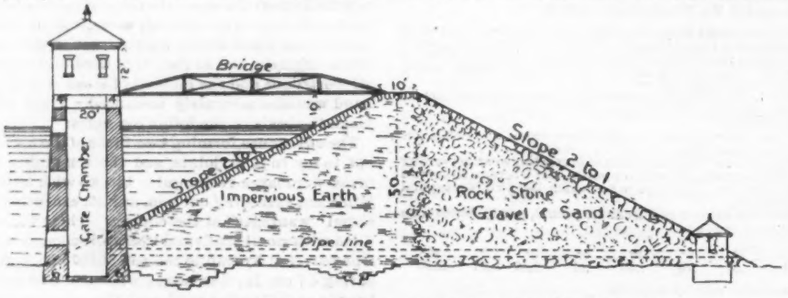


Fig. 1. Cross-Section of Earthen Dam, Gate-Chamber, Etc.

The causes of failure in earthen dams are;—(1.) From insufficient or improperly located or constructed spillways, which make possible the overtopping of the dam by water in time of excessive flood. (2.) From improperly built outlets. (3.) From imperfect connection between the natural earth and the constructed earthen embaankment, either under the dam or at the ends. (4.) From the lack of impervious material in the base.

Stone dams are generally used when the foundation is rock. But as in many cases the bed-rock does not rise on one or both sides of the valley to the height of the proposd dam, the end walls may necessarily be buried in the earth. Such dams very generally fail at the earthen end connections; as was

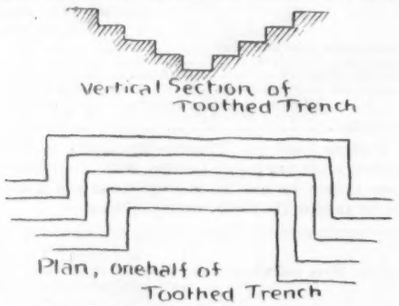


Fig. 2. Terracing and Pipe Masonry.

the case in the original Croton Dam designed by no less an engineer than Mr. J. B. JERVIS.

Framed timber dams are often filled with stone, with a sloping water front and a flatter slope of gravel extending up stream. Tree and brush dams are used where the bed of the stream is of loose or porous earth; but these latter are more generally employed in river training, etc., and they can hardly be included in the dams under discussion. Nine-tenths of the timber dams proper fail from imperfect connection with the earth at the ends, and a few from undermining.

HOW TO BUILD A SAFE EARTHEN DAM.

An axiom, which it is believed was original with Mr. MCALPINE, should be impressed upon the minds of all young hydraulic engineers, and that is—"That water abhors an angle." To force the water to go around an angle is to compel it to expend just so much of its original head; and where danger of a leak is apprehended, a sufficient number of angles should be interposed to destroy nearly or quite all of its dangerous head. Water so treated is practically deprived of all power of mischief, even if it does escape through the dam.

Where the base and sides of a valley on which a dam is to rest are of a pervious material, a suitable impervious base must be sought for. But if the safer material lies at too great a depth, the base of the dam may be extended up-stream by a deep water-tight lining, and so load down the porous material below. The base of such an extension must be "toothed" at frequent intervals, so as to cut off any continuous flow, as is imperative under the whole upper half of all earthen dams. This toothing should be connected but not in continuous lines or steps, as shown in Figs. 2 and 3. The sides of the valley (for the upper half of the dam) should be first cut into terraces and then cross-trenched in zig-zags as shown in Fig. 3. The object of all this is to interpose as many "angles" as possible, as water will flow along a smooth, straight surface to an indefinite distance.

Where rock forms the base, the trenches and terraces should be cut in the same manner; but they may be smaller and filled with concrete, extending upward 2 or 3 ft. into the earthwork of the dam, and the surfaces of this concrete in contact with the earth must not be smooth, but on the contrary should be made as rough and jagged as possible.

The outlet of the reservoir should be made through the deepest portion of the earth dam, and "almost never" on the sides or separate from the dam; though this disposal is in direct opposition to the opinions of many old engineers, who knowing that this is the most dangerous part of the work, desire to remove it from the dam itself. It is seldom that a suitable or entirely safe outlet can be found remote from the dam, and a breach at this important point is almost certain to extend to the dam itself and endanger, if not destroy it also. Besides this, these outlet passages are generally required to be placed nearly as deep as the bottom of the reservoir and from the limited size of their trenches, it is exceedingly difficult to render them water-tight in the immediately surrounding material.

On the other hand, when the outlet is located in the middle of the main bank it can be built with every precaution necessary for safety and under constant inspection. Whether these culverts are of stone or made of cast-iron pipes they should have a strong, unyielding foundation. This is absolutely essential because of the unequal pressure upon them from: (1) The varying depths of water at the upper end. (2) The fact that under the crest of the dam there is, say 10 ft., more depth of earth than water. (3) There is a diminishing weight of earth out to the toe of the outer slope. Any yielding of foundations under these unequal conditions means a breaking of the bond between the outer sides of the culvert and the earthern dam, cracks in the material, leakage, and finally failure.

These culverts should have several belt-walls extending several feet deeper, wider and higher than the exterior surface of the walls of the culvert proper, to cut off all water-films. Above all things remember that all surfaces of masonry in contact with the earth should be *very rough and jagged*, and thus present those "abhorrent angles" which mischievous films of water so much detest. And to secure the proper class of masonry it was customary in Mr. MCALPINE'S time, to conclude instructions to the inspector by telling him, that "You will have to kill at least one mason before you can teach the gang how to properly back up such walls." The tendency among stone masons is almost invariably to put the best face of the stone out in the attempt to make "smooth work"; whereas just the reverse is wanted here, and if the stone has no rough face, one should be made for it with the stone hammer.

Mr. MCALPINE preferred cast-iron flanged pipe laid on an unyielding masonry foundation for his outlets. This masonry enveloped the pipe and had the cut-off walls referred to, and the pipe was laid in a straight line, with at least one foot descent. The pipes themselves should be made of nearly white, homogeneous, smooth surfaced iron, for this material enveloped in masonry is the least corrosive and will last for centuries. The flanged joints will cut off any flow of water along their smooth outer surface. Several pipes are advisable to provide for an obstruction in any one of them; by being laid straight an obstruction can be forced out from the lower end by a long rod; and if they are 24 ins. in diameter a man can enter them.

The embankment should be made up of two sections (see Fig. 1); the upper one on the water-side, extending to about the rear top angle, to be made of impervious material thoroughly incorporated with the water-tight natural earth before referred to, and the lower section to be made of rock and stones selected from the upper section, and the interstices filled with gravel and sand or earth so as to render it compact and solid. The first section presents a water-tight barrier and the second adds to the first its weight and mass in resisting horizontal pressure.

The upper section should be made of gravel, sand, loam and clay, properly proportioned and mixed, put on in layers of 6 ins., moistened and then compacted by heavy iron grooved rollers. Only water enough must be used to dissolve the lumps and thoroughly moisten the mass, but not enough to render it

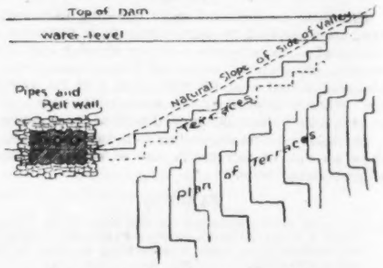


Fig. 3. Sketch Showing Toothing.

quaking; for the latter condition involves the final drying out of the surplus water and leaves the mass porous and liable to leakage. All stone of more than 10 lbs. weight should be taken out and deposited in the lower section, and any stone unavoidably left should be entirely surrounded by earth. The layers must be kept levelled in both directions over the whole bank, including the lower section which must also be carried up simultaneously with the upper portion.

When it becomes necessary to carry up one part of the bank higher than an adjacent part, this should be done in steps of about one vertical to four horizontal, and when these gaps are filled up the layers must lap over the higher portion, and the latter must be broken up loosely and the two layers combined by again wetting and rolling.

No puddle-wall should be made through the bank, for the effect of puddling is to render the earth more compact, and its eventual settlement will be less than that of the adjacent unpuddled earth. And by reason of this unequal settlement, in time a vertical crack will be produced extending along both faces of the puddle wall, and into these cracks rain or seepage water will settle and make almost impossible a subsequent union of the two masses. These same remarks apply to walls of masonry or lines of sheet-piling, neither of which should be placed in the heart of an earthen embankment. The sole object should be to render the whole mass of the upper section homogeneous and entirely impervious of itself alone.

At the sides of the valley, at the rear of the terraces, adjacent to the pipe walls and elsewhere that the rollers cannot reach, the earth must necessarily be rendered solid by a species of puddling just sufficient to compact the earth as much as is done by the rolling adjacent.

A layer of gravel 2 or 3 ft. thick should be laid on the water slope of the bank, on which should then be placed a slope wall of field or quarry stone closely chinked in with smaller stone. This facing should be 2 or 3 ft. deep at the bottom, and 1½ ft. at the top; and it should be carried to the very top to protect the earth against wave washing. The stone on the rear slope should also be laid close and chinked. The top of the bank should be sloped one in ten towards the rear, and turfed or paved with small stone.

Springs will frequently appear at the base of the embankments. But they generally have only a small head, and when several occur contiguous, they can be collected into one place by small brick drains. To stop these springs build up a small brick well over the outlet and as high as the water will rise in the well; then pour in liquid cement (unmixed with sand) and follow with gravel concrete and finish by a stone cover laid in cement. In this connection long experience and careful experiments have proven the fact that if tight and substantial work is aimed at, this grouting must be done with good cement alone. If sand is used with the cement, it separates from the cement, the mixture ceases to be mortar and the sand blocks the channels and prevents the flow of the grout to the lower or distant cavities, and leaves above the obstruction a layer of practically pure sand covered by purer cement. During the construction of the Brooklyn Dry Dock, nearly 40 years ago, grouting was prohibited by Mr. MCALPINE, Engineer in Chief, although the reverse was then the almost universal practice of the Government engineers. A commission was appointed to investigate the effect of this departure, among others, from the then approved practice, and Maj. R. E. LEE, one of the commission, had built under his personal inspection a section of dry wall, carefully chinked and as carefully grouted. When this wall was torn down the condition of things above described was found, unfilled cavities below, sand above and pure cement on top, just as the Engineer in Chief had foretold.

During construction two wooden flumes should be used to carry off the flood water of the creek over the unfinished bank, used alternately as the earthwork is carried up; and great care must be exercised in filling up the spaces in the bank occupied by these flumes when the latter are removed. The outlet pipes should also be kept constantly open to prevent the water rising in the pond above, at least, until the dam is built to half of its intended height.

Spill-ways should be placed as far away from the dam as possible, and they must be protected against floating ice, timber, etc. The water-surface in the reservoir must never be allowed to rise higher than a point 5 ft. below the top of the dam (*i. e.* above the point of deepest frost penetration). The greatest floods will probably result from warm rains on a body of snow, say equal together to 5-in. depth of rainfall, and the length of the weir should be sufficient to discharge this quantity over a full reservoir, *exclusive of any aid from* waste-pipes or over flow at the gate-chamber. The latter must be regarded as only extra provisions for the escape of surplus water; the self-acting waste-weir should be independent of all human frailties.

The upper gate chamber may be placed a little way into the water slope of the dam. In dams holding 50 ft. of water this chamber should be about 16 x 20 ft. in the clear, with walls about 6 ft. thick at the bottom and 4 ft. thick at the top. The front wall should have three gate passages at each of three levels, viz., near the water level of a full reservoir, 6 or 8 ft. above the bottom and midway between these two, and in front of the gate screens should be placed immoveable frames, and in front of the structure itself there should be strong spring wooden fenders to protect the screens and gates from floating bodies of ice or wood. At the top water line the chamber walls should be coped with heavy stone so as to make an overflow (See Fig. 1) of two places 16 ft. long and two of 20 ft. long The outlet pipes, of course, extend into this gate-chamber and they too are provided with gates. The lower gate-chamber can be built in any manner desired.

From these same note books are taken the following memoranda on dams and their failures, etc:

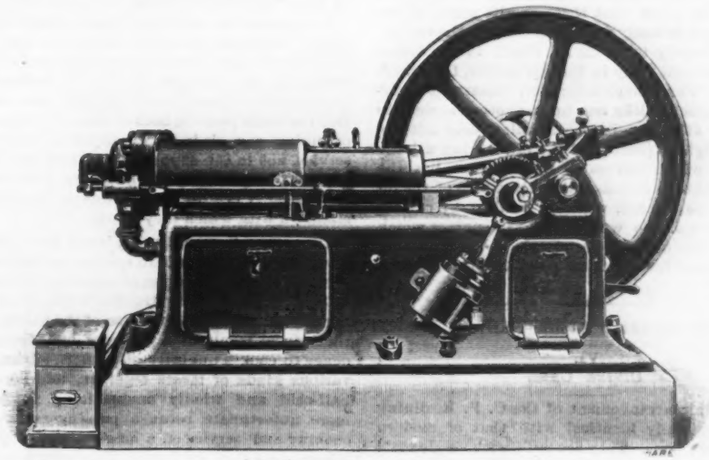
Some Recently Destroyed Reservoir Dams. (1) The Croton Dam of stone masonry. A great flood broke through the north end of the dam. (2) Worcester, Mass., Earth dam. The water followed along the smooth exterior of the outlet culvert and breached the dam. (3) Hartford, Conn., Earth dam. Flood passed over top. (4) Black River, N. Y. Earth dam, with masonry and sheet piling in center. Owing to insufficient and improperly located waste weir, flood overtopped and destroyed dam. (5) Madison, N. Y. Earth dam. Destroyed when half built by flood water passing over top of unfinished work—a flume would have saved the dam. (6) Sheffield, England, failed March 11, 1864. Earth dam, cost $1,635,000. The water followed along outlet pipe and culvert located several hundred feet from the dam, first breached this and then the dam. (7) Vartry, Ireland. Earth dam, destroyed from same cause as Sheffield dam. (8) Cheliff, Algeria. Cut-stone dam. It was breached at the ends and bottom (9) Habra, Algeria. Concrete and rubble masonry dam. One end destroyed by water flowing over dam. (10) Lucberne, Spain. Ashlar masonry dam. Failed in part by undermining. (11) Guardarama, Spain. Stone dam. Failed as in No. 10. (12) Puentes, Spain. Masonry dam on piles. Failed by undermining. (13) Allicante Spain. Ashlar masonry dam. Failed as in No. 10.

The Erie Canal, 360 miles long, in a great many places forms a series of earthern dams, ranging from 10 ft. to 50 ft. in height, with water from 7 ft. to 30 ft. deep behind them. These banks were generally made of water-tight earth with vertical puddle walls in the middle. Many of these banks have failed from improper construction. In a dozen or more places the wheeling planks used in construction had been covered up, and thus provided for the escape of the first film of water which finally resulted in a breach. In another case an old tow-rope left in the bank resulted in a breach. A third unlooked for source of trouble resulted from the dumping from the wheeling planks, running across the bank, of material containing small stones. This stone naturally rolled to the foot of the slope and practically formed a blind drain which eventually brought about a leak. Leaks usually showed themselves at the foot of the banks, and as long as the water ran clear no danger was apprehended. But when the water was colored or muddy a breach soon followed unless the leak was at once stopped. More breaches occurred at the masonry ends of the aqueducts, etc, on the Erie canal than in the earthwork proper.

The Priestman Petroleum Engine.

The advantages of a self-contained engine, one which requires no fire, boiler or constant attention, are obvious, as there are many cases where power is necessary, or can be advantageously applied, but where there are objections to the use of steam engines and boilers on account of the expense, trouble and dirt, and the amount of attention required. Self-contained engines, are particularly adapted for driving pumps, electric dynamos, elevators, small machines, etc., for private establishments or in small plants; also for general motive power purposes, railway water supply stations, machine shops, etc., etc., and in these and similar places there is quite an extensive field for the introduction of a safe, efficient and inexpensive engine which requires little attention and does not easily get out of order. Gas and naphtha (or benzine) engines have been brought out, but the former have not been generally adopted in this country on account of the high price of gas, and with the latter an increased rate of insurance is charged.

We illustrate this week the Priestman petroleum engine, a type of self-contained engine which is already in extensive use in England, where satisfactory results have been obtained, and which is now being introduced into this country by the manufacturers, Priestman Bros., of London and Hull, the makers of the well known Priestman dredger, who propose to make arrangement for its manufacture here, under the Priestman and Hume patents. The engine burns petroleum, or other oil, and is entirely self-contained, requiring no pipe connections.



The Priestman Petroleum Engine.

A tank in the front end of the upper part of the bed contains a supply of oil sufficient for a working day of 10 hours; the vaporizer is at the rear end of the bed, and consists of a chamber heated by the exhaust from the cylinder: just before starting the engine the chamber is heated by a small oil lamp. From the tank the oil is conveyed to the chamber, where it is vaporized and then by a jet of compressed air injected into the cylinder, where the charge is exploded by an electric spark, and the expansion of the gases drives the piston forward. The engine is single acting, and is very simple in construction. The admission and exhaust are controlled by two mushroom valves, and the valve rod is operated by an eccentric on a shaft driven by cog gearing from the main shaft: the gearing is 2 to 1. A plunger pump driven from the same eccentric maintains a circulation of water round the cylinder to keep it cool, and the bed plate forms a tank to supply water to this circulating pump. A small bichromate battery is used for firing the charges, the contact being made by a short projecting arm on the valve rod, as shown on the engraving.

Two of these engines may now be seen in operation at 106 Washington St., New York City. One is a 6 H. P. and the other an 8 H. P. engine; the latter has a cylinder 8 ins. × 12 ins. and makes 175 revolutions per minute. Two kinds of oil have been used; fuel oil costing 4 cts. per gall., and fine oil costing 6 cts. per gall.; the consumption is 1.4 to 1.7 pint per H. P. per hour. Crude petroleum can also be used. The engine is safe, and no extra charge is made for insurance.

In England the engine has met with great success, and many orders have been received from abroad (Australia, Egypt, etc.), as oil is so easily obtainable. It has been used to drive pumping and other machinery, private electric light plants, etc., and the Manchester Ship Canal Co. has one on a barge. It is also made in portable form, and has been applied experimentally to a launch, street car motor, etc. The sizes made at present range from ⅓ H. P. to 10 H. P., but 15 and 20 H. P. engines will probably be put on the market.

Very satisfactory reports, from actual tests, have been made by Sir WILLIAM THOMSON, M. I. C. E.; Sir SAMUEL CANNING, M. I. C. E., BOVERTON REDWOOD, F. C. S., and others, and we extract the following from Sir WILLIAM THOMSON's report.

"I made careful tests on a 6 H. P. engine. After seeing it started and stopped several times, and kept running on the brake for an hour at 7¼ H.P., and for two hours at 6 H. P., without measuring the oil, I gave it exactly an hour's run with the brake loaded slightly more than for 6 H. P., and with arrangements to measure the oil accurately. The result was that the engine ran with very admirable regularity at from 158 to 160 revolutions, doing 6.43 H. P. on the brake. The quantity of oil used was very exactly 11 pints, being at the rate of 1.71 pints per hour per brake horse-power [equal to about .85 of a pint per I. H. P. per hour], or 1.69 lbs. per hour per brake H. P., which seems to me remarkably good economy, considering the great difficulties which had to be overcome in using the combustion of oil directly as a motor. It must be noted that these results refer to the H. P. of work actually done externally by the engine, and not merely to I. H. P., which in the steam engine, and still more in the gas engine, falls short of true H. P. by a large difference. Messrs. PRIESTMAN'S engine, unlike one upon another system to which my attention has been called, does not use only the lighter portion of the oil, leaving a large residuum which cannot be utilized, but has the great advantage of consuming the whole of the oil put into the cistern, which I verified by careful examination of the working of the engines which I tested. The engines are simple in construction, and there are few working parts liable to get out of order."

The Canadian Pacific Railway.

VI.

DINING CARS.

The interior arrangement of the C. P. R. dining cars is practically identical with that of modern cars on other lines. They are built with single seats on one side of the car and double seats on the other, thus accommodating in practice about as many diners as if there were double tables on both sides, with a great increase in the comfort and ease of service. Like all the C. P. R. rolling stock the cars are admirably finished, but they have no distinctive peculiarity, like the sleeping cars we described last week.

There being but one through train a day over the line, the dining car service is so arranged that a car may be attached in the morning, serve three meals during the day, and be dropped off at night at some point where it can take the returning train at an hour convenient for serving breakfast, and so return again to where it started from. If the return train be late, it is simply hauled ahead a little further the night before, the only inconvenience (which is sometimes very inconvenient) arising when a train is delayed during the evening or night, too late to give notice to have the diner hauled ahead further.

In this way a pair of cars remain in service vibrating past each other on the same division indefinitely, being in motion on an average about 12 hours per day only, and standing still during the night on a side track. This has the advantage that the cost of hauling the car by night as well as day is saved and possibly also that the crew become a little more familiar with the routine of obtaining supplies, so that there is less danger of a failure. On the other hand, there is a certain delay night and morning for switching the car on and off, an occasional great annoyance from not having the car at hand when most needed, in case of delay, and more than all else the loss of a very effective check on the quality of the cooking and service (on which, and not on the supplies the goodness of the meals mainly depends) as compared with a car running through with the same passenger for a 5-day trip, so that if on one car the cooking and service were good and on another bad, the fact would very soon be determined. Moreover, with a 5-day trip ahead of him the waiter would naturally be anxious to earn a fee, and would have an opportunity to become familiar with the tastes of passengers which is impossible under the intermittent system. That the service is likely to be better with cars running through for a 5-day trip with the same passengers than with different passengers every day is apparent, and it is probably for this reason in part, with others perhaps special to the line, that the Northern Pacific changed its system some time ago, and instead of running cars by day only, a new car each day, now runs the same car through from St. Paul to Tacoma.

On the other hand there are certain objections to running cars through, besides the great one of the extra expense of hauling, as notably that the car must be a sleeping car at night for the crew, whereas the C. P. crews, for the most part, sleep away from the car. But the cost of hauling is merely for fuel, since the engine must, on the C. P. at least, be as well able to haul the car by night as by day, and since dining cars are not expected to be profitable any way, and the additional cost for fuel to haul them through would add but a slight percentage to the loss on them, if it added a consider ably greater percentage to the excellence of the meals served, and hence to the comfort of passengers who are obtained by competition, it would plainly be a a profitable investment.

In practice we anticipate that it would have this effect, although the meals served on the C. P. R. cars are, to put it mildly, at least as good as are served on the Northern Pacific, in spite of much greater difficulties in keeping the cars supplied. But the weak point in both of them, as in most lines of dining cars, is in the quality of the cooking and service, not in the supplies furnished, and the tendency of most dining car lines, we have observed, is to steadily fall off in this respect, from the high standard with which they start.

The reason, it seems to us, is not far to seek, nor would it be worth while to speak of of it except that the cure is in the direction of economy instead of additional expense. The trouble is *too much bill-of-fare* as compared with the size of the kitchen; with the natural result of a stronger and stronger tendency to cook a quantity of stuff in advance, cook various kinds of meats together, and serve them half-cold and wholly unappetizing. This is the more unfortunate because passengers need good cooking and service on a long railway trip if anywhere, since they are for the time being cut off from all exercise. Then, if ever in his life, the passenger "wants but little here below, but wants that little"—good. Better by far for him, a dinner of herbs daintily served than a stalled ox and cold gravy therewith which has likewise some flavor of mutton; and it is simply impossible to avoid such accidents when 20 or 30 different articles for 30 or 40 people—or half that number—are to be cooked and served in a little box about 7×13 ft. Nor can it well be helped that cooks struggling with such difficulties should gradually grow more and more careless about serving the varying orders which they receive in first rate shape.

We predict for that dining car line a great success which first has the courage to abolish the bill of fare, which not one in ten of the passengers knows how to order from discreetly, and serve simply a *breakfast* or a *dinner*, with the ordering of which the passenger has nothing to do (as he never expects to have when he is to be served particulerly well) and which then it might reasonably be demanded should be in every article of the best. Even in a hotel this would probably be a greater success than the "American plan" of choosing blindly from all the dishes that can be thought of; nay, it is a success in one of the best hotels on this continent as respects its table, the Driard House, of Victoria, B.C, where the guest is not asked for his order and when his meal is placed before him is thankful he was not; and the same is true of all other *table d'hote* meals. Of dining cars this should surely be still more true, because the conditions forbid serving well a multiplicity of dishes. Few of us are conscious of suffering from lack of a bill of fare when we dine or breakfast with a friend. Why should not the railway company take the place of the friend and simply serve an excellent breakfast according to the judgment of its caterer, who knows far better how to serve one than the average passenger does how to order it.

That such service would tend to reduce expenses is apparent, and this seems especially likely to be the case on the Canadian Pacific, where it is especially difficult and expensive to give the passenger a choice between all the dishes ever heard of. The passenger does not really care for it. He probably likes everything on the bill well enough if well served, and more of them badly served, bnt he ends by ordering twice what he really wants, not from piggishness but because he cannot guess in advance what will be cooked to his taste, in the vain hope that he will fare as well as if half of his order were twice as well cooked. But two halves cannot make a whole in gastronomy, although they do in mathematics.

The fact is that the long American bill of fare either in hotels or in dining cars is nothing but an offensive relic of barbarism, a survival of the barbaric notion that a "good meal" means a "perfect gorge." If a man goes to a tailor to order a coat he does not expect to be handed a tape and told to take his own measure to suit his own taste, and why should a man who goes to a caterer in search of a dinner be insulted by having a bill of fare stuck in his face with a demand that he take his own measure for dinner? The dinners that we remember as a pleasure were not thus served to us. The dinners that are served to officers on their own cars are not thus served to them. They know nothing about them till they are placed before them; and although it may be said that this is merely because their cooks already know their tastes, and they do not know their guests' tastes, yet those guest can generally bear with equanimity the absence of a bill of fare, and the considerably smaller quantity of provisions at their disposal.

We have made the C. P. R. dining car service, perhaps somewhat unfairly, the text for some very general remarks on the subject of dining car service, but we repeat that it must not be understood for a moment that the C. P. R. dining service is in especial need of improvement, for it is not so; the service is quite as good as on most lines, in spite of far greater difficulties, but truth compels us to say that it is not better than most lines, in spite of earnest efforts to make it so. In this way outlined, only, or at least most easily, it can be made so, and with much better satisfaction to passengers, to whom it is a more important question than on most roads because they have five solid days of it. They get along very comfortably; but probably few of them remember the dining car service as one of the pleasures of the trip as all of them might be made to do.

We should add that on the run through the mountains dining cars are not used, except on a short run to serve a single meal, but three very dainty little hotels and eating stations have been constructed instead, which we shall speak of more fully in the more detailed description of the line which will begin next week. The primary motive for so doing possibly, was to save hauling dining cars over the mountain grades and curves, but it lends an added charm to the trip, since all three of these hotels are in the midst of scenes of the wildest beauty and grandeur, where it is a pleasure to stop even for an hour, and where many stop for a day or two.

THE false economy of using cheap bridges and dispensing with the services of an engineer is emphatically shown in a dispatch from Boston, stating that "Miss SARAH E. ROLLAND in her suit against the Boston & Providence Railroad Company for damages for injuries received in the Roslindale accident has received a verdict of $23,000." The aggregate of damages, we believe, is now in the neighborhood of $500,000.

Some Valuable Train Resistance Tests.

Chicago, Burlington & Quincy Railroad.
AURORA, Ill., Nov. 8, 1888.

EDITOR ENGINEERING NEWS:

Referring to your recent articles (Sept. 1, Oct. 6, Oct. 27) on the subject of train resistance, and especially of the large amount consumed by an engine at high speeds, I enclose results of some tests which we made last winter which confirm your views entirely. The tests were made in very cold weather, and the train often encountered high winds and variable ones, and after making a great many measurements we found it difficult and really impossible to deduce any data on train resistance proper which would have a general application.

Referring to diagrams *A*, *B*, *C*, *D*, I am unable to account for the sudden increase in the per cent. of engine resistance at speeds above 50 miles an hour, but it seems to be the rule for the several classes of

engines tested, and for nearly all of the tests made. If you desire any further information in relation to this test and will ask for just what you want, I will be glad to furnish it if possible.

Yours truly, R.

[The accompanying report is one dated Aurora, Ill., Oct. 13, 1888, and addressed to GODFREY W. RHODES, Esq., Superintendent of Motive Power, C. B. & Q. R. R., and is as follows:]

During the engine trials of last winter a large number of indicator cards were taken from each of the engines tested. These indicator cards, in connection with simultaneous dynamometer records, furnish the data for obtaining the results regarding the relation between the engine and the train resistance.

The indicator cards show the total horse-power of energy developed by the locomotive, while the dynamometer record denotes the portion of this energy absorbed in moving the train back of the tender. The former is the total resistance of engine and train combined, and the latter, the resistance of the train alone. The difference between these two is the resistance due to the engine and tender.

The result obtained from the comparison of indicator and dynamometer cards are graphically shown in the "curves of resistance" on prints attached (*A, B, C, D*). They show the variations in resistance of engine and train at the speeds at which the indicator cards were taken. These curves are constructed by taking the speed as the ordinate and the train resistance, expressed in per cent. of the total resistance, as the abscissa. The mean or resultant curves are shown together on a single sheet for the purpose of comparison.

The large prints* show typical cards from each engine tested, and show the data from which the curves were constructed. The indicated H. P. is the *total* resistance. The dynamometer H. P. is the *train* resistance and the difference between these two is the *engine and tender* resistance. The relation between the train and total resistance is shown in dynamometer H. P. in per cent. of indicated H. P.

The figures in the column denoting the relation between the train and total resistance show a variation with the speed, indicating in all cases that at slow speeds the major part of the total resistance is due to the train. At high speeds the engine resistance exceeds that of the train, increasing very rapidly with the speed, indicating that when a certain speed is attained, the power of the engine is all consumed in propelling herself.

The curves plainly indicate the great increase in head resistance with the speed and the consequent decrease in the available power to overcome train resistance.

Comparing the resultant curves for the four engines tested, we observe the curves are approximately parallel, indicating the same law of variation in each case. Also, that the curves of the four wheel connected engines, Nos. 138 and 352, are distinct from those of the six-wheel connected engines Nos. 135 and 157, and in all cases are below those of the larger engines, clearly indicating that the resistance of the heavier engines is less in proportion to the total resistance or power developed, than in the case of the smaller engines, and consequently, that the larger and heavier engines give to the work of overcoming train resistance, a larger per cent. of their total H. P. than do the smaller types of engines.

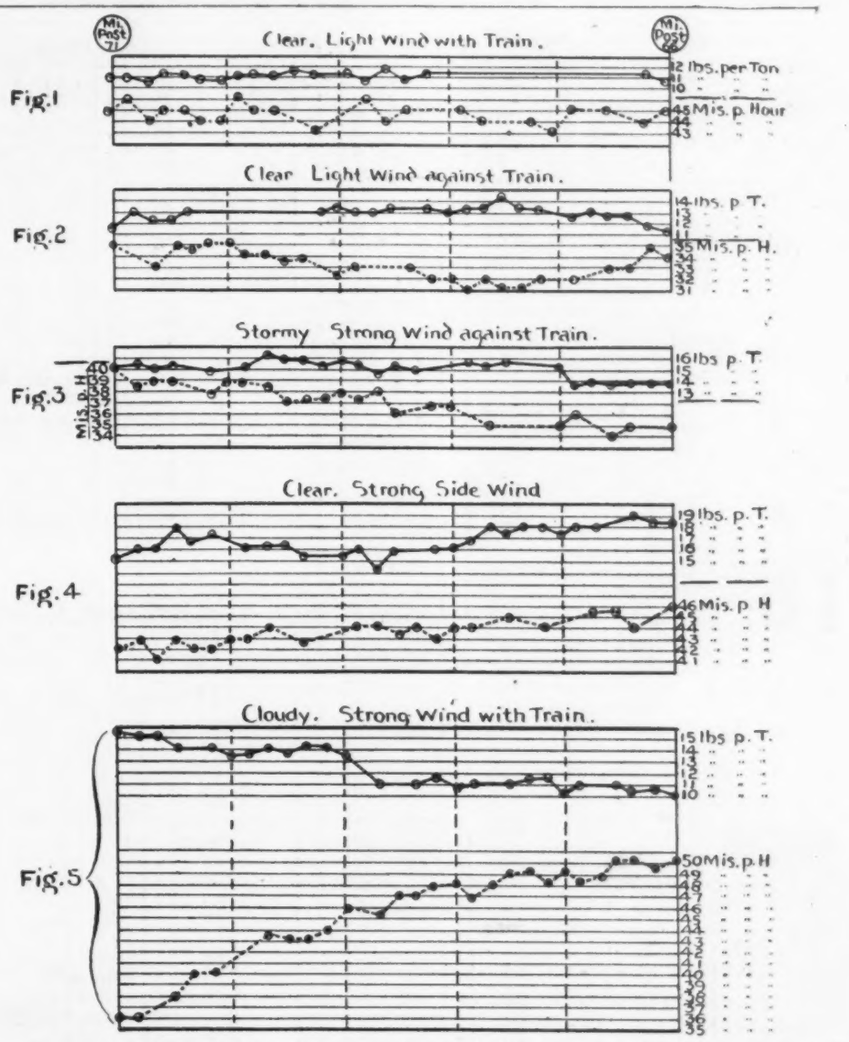
This fact probably accounts for the higher efficiency of the larger engines shown by the comparison of the actual work done by each engine with the theoretical work in the water evaporated by each engine, at the boiler pressure while doing the work, Tables 4 and 5.

Total Work of Train Resistance overcome, expressed in per cent. of the theoretical work in the water evaporated at boiler pressure.

Engine 135 C. B. & Q. R. R.	Ave.	5.8 p.c.	Efficiency.
" 157 C. B. & N. R. R.	"	4.8 "	"
" 138 C. B. & Q. R. R.	"	4.4 "	"
" 352 C. St. L. & P.R.R.	"	4.2 "	"
Heavy 3-wheel connected eng.	"	5.0 "	"
Light 2-wheel " "	"	4.3 "	"
Favor of heavy engines		0.7 "	"

These figures show approximately a gain of, in round numbers, 1 per cent. in efficiency, in favor of the larger engines.

*Not engraved.—ED.



Dynamometer Record of Train Resistance on Level Tangent; Chicago, Burlington & Quincy Railroad. (Curves show pull in pounds per ton behind tender for speeds in miles per hour.)

TABLE 6.—TRAIN RESISTANCE RECORDS IN VARYING WEATHER (Cars only).

Clear Day, No Wind.

Train 327 Tons			Train 344 tons		
Mile post	Speed	Pull lbs. per ton.	Mile post	Speed	Pull lbs. per ton.
43	44	12.8	43	47	9.6
44	40	14.2	44	43	9.6
50	53	10.8	50	32	8.2
60	55	12.5	60	43	10.4
66	53	12.5	66	46	9.5
75	53	11.5	75	45	9.6

Clear Day, Strong Wind With Train. (Fair)

Train 317 Tons			Train 412 Tons		
Mile post	Speed	Pull lbs. per Ton.	Mile post	Speed	Pull lbs. per ton.
43	37	8.0	43	44	8.0
44	38	8.3	44	43	8.1
49	39	9.7	49	43	12.2
50	40	8.2	50	40	11.9
60	45	9.0	60	43	7.5
66	45	8.8	66	44	6.4
75	42	7.2	75	50	8.7

Comparing the same engines with regard to the percentage of total indicated power expended back of the tender in overcoming train resistance, we have taken the average of the curves between 20 and 45 miles per hour.

Proportion of total power expended in the work of overcoming train resistance.

Efficiency.		
Engine 135 C. B. & Q. R. R.	Ave.	75.0
" 157 C. B. & N. R. R.	"	71.5
" 138 C. B. & Q. R. R.	"	83.3
" 352 C. St. L. & P. R.R.	"	84.2
Heavy 3-wheel connected eng.	"	72.2
Light 2-wheel connected eng.	"	83.8
Difference in favor heavy engines.		9.8

Or in round numbers, a gain of about 10 per cent.

Clear Day, Strong Wind Against Train. (Head)

Train 267 Tons			Train 289 Tons		
Mile post	Speed	Pull lbs. per ton.	Mile post	Speed	Pull lbs. per ton.
43	39	8.9	43	45	9.0
44	40	10.3	44	44	9.5
49	39	8.1	49	38	7.3
50	40	8.8	50	38	6.2
60	39	11.2	60	41	5.2
66	41	11.6	66	51	9.0
68	41	12.1	75	50	8.0

Clear Day, Strong Side Wind.

Train 275 Tons			Train 339 Tons		
Mile post	Speed	Pull lbs. per ton.	Mile post	Speed	Pull lbs. per ton.
43	40	20.1	43	38	12.4
44	42	19.5	44	37	12.7
49	49	16.7	49	40	12.8
50	40	18.9	50	41	10.7
60	44	19.8	60	41	13.5
68	44	16.1	68	40	13.9

in the proportion of total work sent back of the tender.

These results corroborate the results of the trial on the basis of fuel consumption and indicate the superiority of the larger and heavier engine for heavy and fast train service.

The coincidence of the curves of engines 138 and 352 indicates that these engines consume about the same proportion of their total power in moving themselves.

The divergence of the curves of 157 and 135 would seem to indicate the superiority of engine 135, especially at high speeds, but the low position of the curve of 157 may be in a measure due to the fact

TABLE 2.—RECORD OF ENGINE TESTS, CHICAGO, BURLINGTON & QUINCY R. R., JANUARY AND FEBRUARY, 1888.

TRAIN NO. 1, AURORA TO GALESBURG. Time 2.78 hours, by card. Streator coal.

No. of trip.	Date of Test	Engine, No.	Total weight of train, tons.	Distance run in miles. Steam worked.	Steam shut off.	Total.	Time in hours. Actual running.	Lost in stops	Total.	Steam worked.	Steam shut off.	Speed, Average. Steam worked.	Steam shut off.	Entire run.	Average boiler pressure, pounds.	Consumption, pounds. Coal.	Water.	Evapora. lbs. of water p. lb. of coal. At boiler pressure.	From and at 212°.	Water in tank.	Temperature, average. Air.	Dynamometer Record. Work in Foot-Pounds, exclusive of engine and tank resistance. Total.	Per lb. of steam from and at 212°.	Per. lb. of coal.	Economy exclusive of engine & tank resist'ce. Lbs. per H. P. per hour of train resistance.	Weight of train, exclusive of engine and tank, tons.	Av. train resistance, lbs. p ton while eng. is working steam, excluding engine & tank resistance.	Weather. Clear or stormy.	Wind.	No. of times train started.	Nozzle.	Stack.
1	Jan. 26	135 C. B. & Q.	346	114	59	10	38	124	57	3	26	47	3	75	2	98	3	37	9	145	8744	49700.	5.6	6.9	36.5°	16°	2,876,251,000	44,000	306,000	6.5	45 0	270	16.4	Clear.	None.	7–3	ins. double.	Diamond.
3	" 30	" "	344	111	76	13	29	125	00	3	34	45	3	69	2	57	3	13	2	131	9013	55511.	6.2	6.9	40°	38°	2,874,732,000	42,000	290,000	6.8	47 0	265	18.4	Fair.	None.	14–3	"	"
23	Feb. 22	" "	475	119	95	6	70	125	00	3	34	45	3	69	2	57	3	13	2	131	14639	58967.	4.0	4.8	42°	41°	3,297,929,000	46,000	221,000	9.0	43 0	305	13.3	Clear.	Strong side wind.	6–3	"	Straight, no net.
13	" 15	C. B. & N.	467	118	75	6	30	125	00	3	34	45	3	69	2	57	3	13	2	155	14691	71092	4.9	6.0	37°	-5°	2,952,358,000	37,000	201,000	9.8	59 3	384	12.4	Clear.	Light head wind.	9–4½	"	Straight, ext. front.
15	" 18	" "	477	118	75	6	30	125	00	3	34	45	3	69	2	56	3	32	2	156	14454	72824.	5.0	6.2	40°	43°	3,212,309,000	36,000	222,000	8.9	55 2	394	13.0	Clear.	Light head wind on quarter.	7–4½	"	"
17	" 15	" "	475	118	47	6	46	124	93	3	34	33	3	67	3	13	21	37	9	90	8.37	4154	13783.	58619.	4.2	5.3	37°	2,979,547,000	41,000	216,000	9.2	47 8	391	12.2	Clear.	Light fair wind.	7–4½	"	double.
19	" 17	136 C. B. & Q.	329	115	94	9	02	124	96	3	46	28	3	74	3	16	30	36	7	96	1142	45731.	5.5	6.8	33.5°	40.5°	2,876,341,000	33,000	227,000	8.7	59 2	297	11.5	Clear.	Strong head wind.	6–2½	"	ins. double.
7	" 3	362 C. St. L. & P.	343	113	35	11	64	124	99	3	30	45	3	75	2	92	38	38	3	30	4 37	9130	5.0	6.1	34.5°	33°	1,345,905,000	28,000	172,000	11.5	70.5	275	8.4	Clear.	Strong fair wind.	6	2½	2⅜	ins. double.

TABLE 3.—TRAIN NO. 6.—GALESBURG TO AURORA. Time, 3.67 hours, by card. Galesburg coal, "Bryant."

2	Jan. 27	135 C. B. & Q.	435	113	10	9	88	124	98	3	62	47	4	00	3	26	36	34	7	27	6	31	6	10	11097.	55599.	5.0	6.2	40°	29°	3,114,769,000	46,000	283,000	7.0	43 0	346	15.1	Clear.	Light side wind.	9–3½	ins. double.	Diamond.
4	" 31	" "	406	114	49	10	51	125	00	3	15	33	3	74	2	84	31	40	5	33	6	33	7	53	11552.	54390.	4.7	5.8	42°	29°	3,827,380,000	42,000	245,000	8.1	46 9	327	14 3	Cloudy.	Strong fair wind.	10–3½	"	straight, no net.
24	Feb. 25	" "	407	115	61	9	43	125	00	3	00	33	3	42	2	95	32	43	1	31	3	41	7	54	12787.	54165.	4.2	5.2	41°	38°	2,568,106,000	38,000	200,000	9 9	51 4	344	12 8	Clear.	None.	11–4½	"	straight, ext. front.
14	" 10	157 C. B & N.	427	115	91	9	14	125	05	3	40	1	32	4	03	3	07	33	2	34	3	33	1	55	14033.	59254.	3.6	4.7	37°	13°	2,329,280,000	34,000	196,000	12 7	57 2	338	11 7	Clear.	Strong fair wind.	9–4½	"	"
16	" 16	" "	412	116	70	8	34	125	04	3	18	33	3	51	2	91	28	40	2	31	3	33	3	53	12712.	47143.	4.5	5.6	40°	35°	2,450,162,000	35,000	197,000	12 6	61 0	298	10 3	Clear.	Light fair wind.	10–4½	"	double.
20	" 18	136 C. B. & Q.	398	116	25	8	71	125	00	3	22	33	3	57	2	91	31	41	0	34	3	33	8	41	11931.	43733.	3.8	4.8	40°	34°	1,572,280,000	32,000	156,000	13 2	61 2	289	9 7	Snow.	Strong head wind on quarter.	8–2½	ins. double.	Straight ext. front.
8	" 4	362 C. St. L. & P.	356	117	35	7	64	124	99	3	03	33	3	03	3	69	27	35	0	24	3	37	3	22	11532.	43733.	3.8	4.6	40°	34°	1,729,760,000	32,000	164,000	13 2	61 2	289	9 6	Clear.	Strong fair wind.	8–	"	"
10	" 6	" "	385	116	45	8	54	124	99	3	46	41	3	87	3	13	33	37	3	25	6	33	2	23	12233.	48183.	3.9	4.8	47°	25.5°	1,867,958,000	32,000	182,000	13 6	62 4	317	9 6	Clear.	Light side wind.	9–3½	ins. double.	Diamond.
																																	10–3½	"	straight, no'net.
																																	11–4½	"	straight, ext. front.
																																	9–4½	"	"
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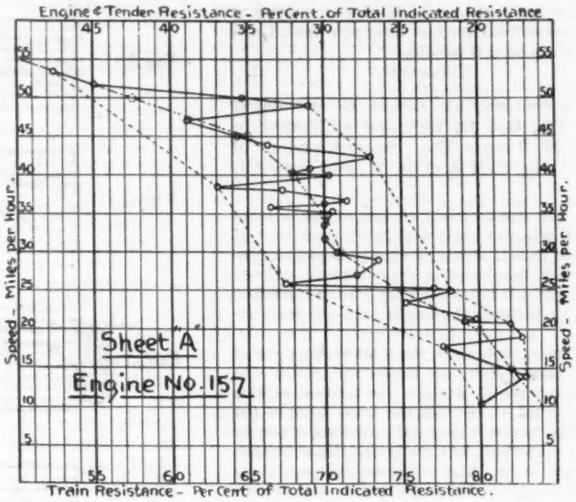
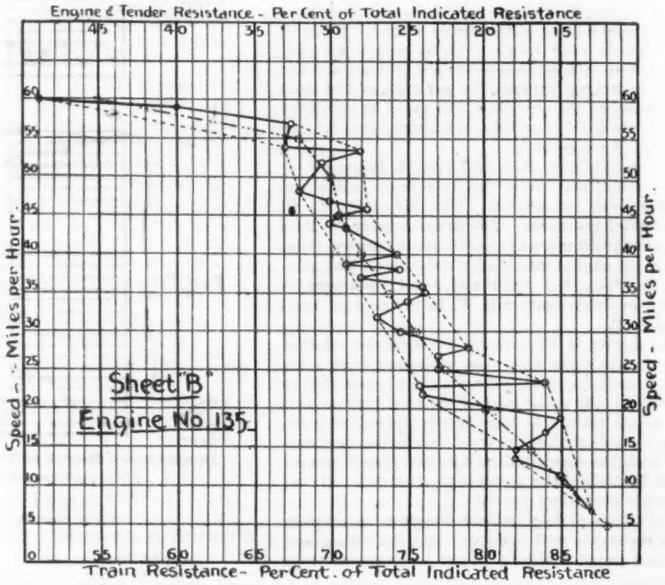
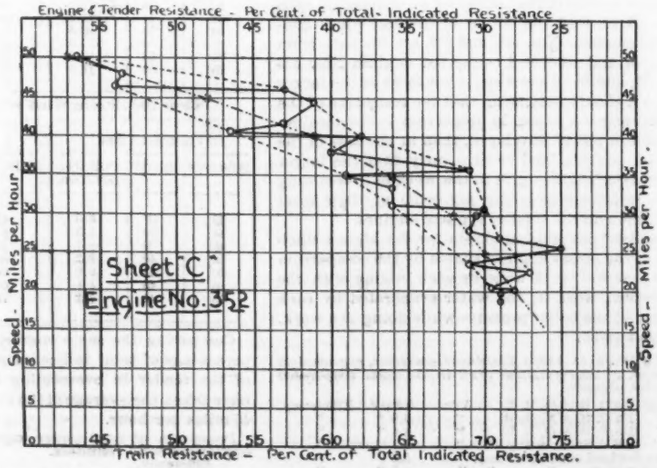

Engine & Tender Resistance - Per Cent. of Total Indicated Resistance
Speed - Miles per Hour.
Sheet "A"
Engine No. 157.
Train Resistance - Per Cent of Total Indicated Resistance.


Engine & Tender Resistance - Per Cent of Total Indicated Resistance
Speed - Miles per Hour.
Sheet "B"
Engine No. 135.
Train Resistance - Per Cent. of Total Indicated Resistance


Engine & Tender Resistance - Per Cent. of Total Indicated Resistance
Speed - Miles per Hour.
Sheet "C"
Engine No. 352
Train Resistance - Per Cent. of Total Indicated Resistance.

Train Resistance Diagrams; Chicago, Burlington & Quincy R. R.

Showing fluctuations of resistance at various speeds, and average of the same, in per cent. of resistance behind tender to total indicated power.

TABLE 1.

ENGINE TESTS, C. B. & Q. R. R., JANUARY AND FEBRUARY 1888.

DESCRIPTION	Engine No. 135 C. B. & Q. R.R.	Engine No. 157 C. B. & N. R. R.	Engine No. 138 C. B. & Q. R. R.	Engine No. 352 C. S. L. & P. R. R.
Type	Mogul	10-wheel	American	American.
Number of wheels coupled	6	6	4	4
Cylinder diameter and stroke	19 ins. × 24 ins.	19 ins. × 24 ins.	18 ins. × 24 ins.	18 ins. × 24 ins.
Diameter of driving wheels	63 ins.	64 ins.	63 ins.	62 ins.
Valves. Pattern	Allen Richardson	Robertson Balanced	Richardson Balanced	Balanced
" Travel	5 ins.	⅞ ins.	5 ins.	5 ins.
" Outside Lap	⅞ ins.	⅞ ins.	⅞ ins.	¾ ins.
" Lead. Full stroke	1-16 ins.	See Note 1-16 ins.	1-16 ins.	⅛ in.
Fire grate area. Square feet	31.5	19.	17.7	16.5
Heating surface. Total square feet	1405.	1546.	1247.	1174.
Tubes. Number	367.	192.	189.	165.
" Diameter	2 ins.	2¼ ins.	2 ins.	2¼ ins.
" Length	11 ft. 10⅜ ins.	14 ft.	11 ft. 6⅛ ins.	11 ft. 1¾ ins.
Boiler, type	Flush Top	Wagon Top	Wagon Top	Wagon Top
Minimum diameter of boiler	56 ins.	56 ins.	51 ins.	54 ins.
Exhaust nozzle. Number and size	Double 3⅝ ins.	Single 4 3-16 ins.	Double 2 15-16 ins.	Double 2⅝ ins. × 3⅝ ins.
Stack. Minimum diameter	See Note 18 ins.	See Note 15 ins.	18 ins.	18½ ins.
Extension smoke box	No	Yes	No	Yes
Brick arch	Yes	Yes	Yes	No
Weight of engine. Working order	110,000 lbs.	118,000 lbs.	81,000 lbs.	92,000 lbs.
" on drivers	92,000 "	90,000 "	54,400 "	58,300 "
" of tank empty	20,000 "	25,600 "	25,950 "	22,500 "
Weight of Engine and Tank, Ave. during test	158,600 "	166,600 "	123,600 "	134,000 "

Note. After Trip 14, lead on valves of Engine 157, was changed from 1-16 in. to 1-8 in. at full stroke.
Engine 135, used different nozzles on different trips, 3 3-8 ins., 3 1-4 ins. and 3 5-8 ins. respectively.
Engine 157, changed exhaust nozzle to 4 1-4 ins. and 4 1-2 ins. respectively on trips 15 and 16.

TABLE 5.

COMPARISON OF ENGINE PERFORMANCE.

Trip	Engine	Weight of train tons.	Ave. boiler pressure lbs.	Foot pounds of train resistance per lb. of water evap'r'tion from and at 212.°	Pounds of w't'r per H. P. per hour of train resistance.	Efficiency. Actual work due to the train resistance expressed in per cent. of the theoretical work in water evaporation at B. Fr. -
1.	135	270	145	44000	45.0	5.9
3.	"	265	150	42000	47.0	5.7
23.	"	396	131	40000	43.0	6.2
2.	"	346	100	40000	43.0	6.2
4.	"	327	153	43000	46.9	5.7
24.	"	327	151	39000	51.4	5.2
13.	157	384	155	33000	59.2	4.5
15.	"	394	158	36000	55.2	4.8
17.	"	391	154	41000	47.8	5.6
14.	"	344	155	34000	58.8	4.5
18.	"	339	153	35000	57.2	4.6
19.	138	275	142	33000	59.2	4.5
20.	"	296	141	33000	60.0	4.4
7.	352	275	150	28000	70.5	3.8
8.	"	280	132	32000	61.2	4.4
10	"	317	128	32000	62.4	4.3
7.85	33	361	138	41600	49.0	5.6
7.85	156	258	140	44000	45.3	5.8
7.85	"	363	128	42000	47.0	5.6

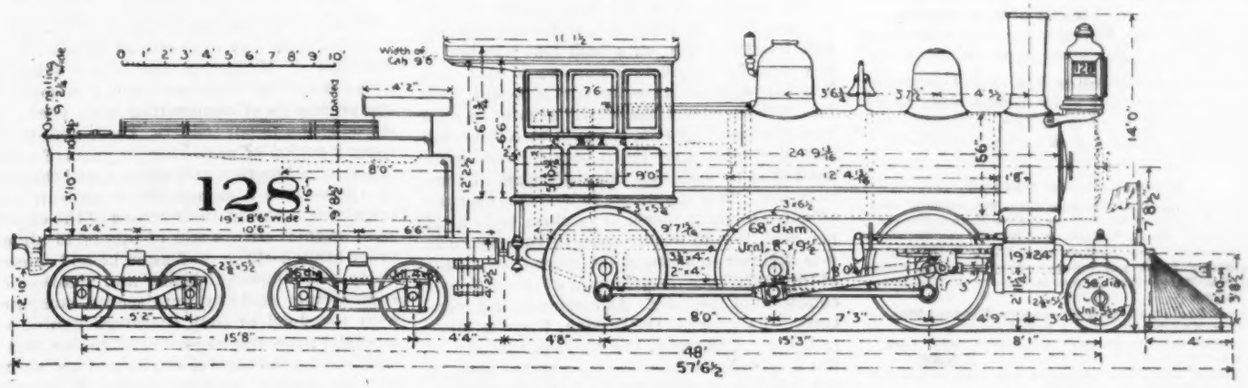


Diagram of Class H Engine, Chicago, Burlington & Quincy R. R.

BOILER

Max Steam pressure	165 lbs.
Type: Straight, Belpaire box.	
Inside dia., smallest ring	56 ins.
Material Steel. Plates	½ ins.
Fire Box 4 ft. 3⅛ in. & 4 ft. 5⅛ in. h. x 3 ft. 6 in. w. by	9 ft. long.
Material, Steel. Plates	⅝ ins.
Tube plates, Steel. Plates	½ ins.
190 Tubes, B. W. G. 2¼ in. dia	12 ft. 4½ in. l.
Water legs	3 in. w
Heating Surface: Fire-box	126 sq. ft.
Tubes, outside	1380 sq. ft.
Grate. Surface	27.1 sq. ft.
Free Section of Tubes	4.15 sq. ft.
Dome 2 ft. 4 in. dia. by	2 ft. 4 in. h.

MACHINERY.

Cylinders	19 in. dia. x 24 in.
Steam ports	1½ in. x 17¾ in.
Exhaust ports	3 in. x 17¾ in.
Steam pipe, Sectional area	19.6 sq. ins.
Valves. Allen-Robertson	
Max. travel	5 ins.
Lead. full gear 1/16, Lap. outside	¾ ins.
" inside	0 ins.
Radius of Link	4 ft. 8¾ ins.
Centers of Cylinders, transverse	7 ft. 1 in.
" " Valve stems, "	6 ft. 4¾ in.
" " Frames "	3 ft. 9 in.
Bumper beam, Eng. 9 ft. long, Tender	8 ft. 8½ in.
Pins; Main 5½ in. dia. x 5⅝ in. long	
Crosshead	3½ in. dia. x 3 ft.
Side rods, front & back	4 in. dia. x 3½ in.
middle	6 in. dia. x 5 in.

TENDER.

Frame, Oak, 21 ft.—4 ins. x 7 ft.—9 ins. Sills	5 in. x 9 in.
Tank, Steel; Top, Bottom & inside	¼ in.
Outside	⅜ in.
Tank, capacity	3,480 gall.
Coal space capacity	8 tons.

WEIGHTS IN WORKING ORDER.

Total on Drivers	91,500 lbs.
Front Truck	18,500 lbs.
Total	110,000 lbs.
Tender empty	20,000 lbs.
3,480 gallons water	20,000 lbs.
8 tons coal	16,000 lbs.
Max. Weight, Total	74,000 lbs.

TABLE 4.

COMPARATIVE ENGINE PERFORMANCE,
Summer of 1885 and Winter of 1888.

Date of Test.	Engine	Weight of train tons.	Ave. boiler pressure. lbs.	Consumption total lbs. Coal	Consumption total lbs. Water	Evaporation lbs. water per lb. coal. At B'iler Pressure	Evaporation lbs. water per lb. coal. From and at 212°	Economy lbs. of Coal per H.P	Economy lbs. of Water per hour of Train Resistance	Temperature Feed Water	Temperature Air About
7.85	33	361	138	6400 G	33821	5.3	6.3	7.5	49.0	70°	80°
7.85	156	259	140	6372 S	37555	5.9	7.0	6.4	45.3	70°	80°
7.85	156	363	128	6028 G	34112	5.7	6.7	6.9	47.0	70°	80°
2.88	138	267	142	8300 S	45731	5.5	6.8	8.7	50.2	39°	40°
2.88	138	296	141	11900 G	46369	3.9	4.8	12.6	60.0	41°	42°
2.88	135	270	145	8744 S	49009	5.6	6.9	6.5	44.6	36°	16°
2.88	135	346	100	11007 G	55509	5.0	6.2	7.0	43.0	40°	20°

that her valves were badly adjusted and she could not do full justice to herself in consequeuce, the high back pressure diminishing considerably her effective power.

It would be very interesting to know the position of a curve showing the variation in resistance with speed for the new Class H. types of engines in comparison with those here given.

It should be understood that the data from which the curves have been constructed can not be considered strictly accurate, but only as approximations, valuable as the large number of observations corroborate each other, and the discrepancies are neutralized by averaging. The fact that only one cylinder was indicated, and that under trying circumstances of temperature and weather, renders anything but a general consideration of the results of each engine taken together of little value.

TRAIN RESISTANCES.

Upon examining dynamometer diagrams with a view of obtaining data regarding the resistance of passenger trains at various speeds, it was found that there were too many variations in the results obtained to furnish any satisfactory information.

Running the dynamometer car over the road on a regular passenger train furnishes data for computing the total work due to the train, but does not give a very good idea of the actual variation of the resistance with speed, owing to the constant change in conditions of weather, track and speed.

Mr. WELLINGTON states as the result of his experiments that "the greater part [⅔] of the indicated train resistance appears to be due to shock and oscillation." Between the speeds of 30 and 50 miles per hour I find resistances varying from 8 to 20 lbs. per ton at uniform speed and on level grades. The blue print attached shows the variations in speed and resistance on a 5 mile level stretch of good track. It should be noted the resistance does not follow any regular law as the speed varies. The effect of wind pressure is a maximum when from one side or quartering. This is plainly shown in the increased pull, Fig. 4. The preceding Table 6 shows some figures taken from the dynamometer records. The speed is uniform at time of observation; the mile posts were on level tangent.

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EDITORS.
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Drawings for publication *should preferably be in plain black and white, considerably larger than they are expected to appear, with letters and figures in pencil only, all lines clean and bold.*

Coming Technical Meetings.

Engineers' Club of Kansas City, Mo.—Regular meeting, Nov. 10. "Present Status of the Electric Railway Problem", Dr. Wellington Adams; "Shrinkage of Material and Settlement of Embankment." Secy., Kenneth Allen, Y.M.C.A. Building.

Engineers' Society of Western Pennsylvania, Pittsburg, Pa.—Regular meeting, Nov. 20. Secy., S. M. Wickersham, Penn Building.

Boston Society of Civil Engineers, Boston, Mass.—Regular meeting, Nov. 21. Secy., S. E. Tinkham, City Hall.

American Society of Civil Engineers, New York.—Regular meeting, Nov. 21. Secy., John Bogart, 127 E. 23d St.

Engineers' Club, Philadelphia, Pa.—Regular meeting, Dec. 1. Secy., Howard Murphy, 1122 Girard St.

Civil Engineers' Society of St. Paul, Minn.—Regular meeting, Dec. 3 Secy., Geo. L. Wilson, City Hall.

Western Society of Engineers, Chicago, Ill.—Regular meeting, Dec. 5. Secy., L. E. Cooley, 171 La Salle St.

Engineers' Club of St. Louis, Mo.—Annual meeting, Dec. 8. Reports of officers and Committees. "Condensers for Steam Engines", Prof. J. H. Kinealy. Secy., Wm. H. Bryan, 709 Market St.

Civil Engineers' Club of Cleveland, O.—Regular meeting, Nov. 11. Report on Railroad Engineering. Secy., James Ritchie, Case Library Rooms.

New England Railroad Club.—Next meeting at Boston & Albany R. R. passenger station, Boston, Mass. Dec. 12.

THE very interesting account which we publish this week, of some tests on the Chicago, Burlington & Quincy Railroad, has a very direct bearing on the question of "Train and Air Resistance," lately discussed by us, but we cannot properly consider it this week. It is apparent at once that it tends strongly to support the views which we have expressed, and to throw doubt on the correctness of the conclusions advanced by *The Engineer* on the strength of some early tests by Dr. LARDNER and others; which have been strangely forgotten, and were well deserving of study, but which did not by any means prove the fact that they were assumed to prove, that form had no effect on air resistance, but rather that there were other causes than air resistance for increased resistance at high speed.

This conclusion seems to be very directly supported by these tests, as we shall attempt to point out more fully in a following issue. In making such tests, the C. B. & Q. is adding another to the great services it has rendered to practical engineering knowledge in the last few years, as notably in respect to train brakes and automatic couplers. That it has done this, and done it so effectually, is chiefly due to one man, Mr. GODFREY W. RHODES, Superintendent of Motive Power, to whose enlightened interest in and able management of the tests it is chiefly due that they led to such preeminently important and now universally admitted conclusions. It is with satisfaction that we note that the same interest and care is being extended to other departments of investigation, of less pressing and evident importance perhaps, but which may well lead to much more important conclusions than can be foreseen in advance.

RIGHT here we venture to suggest one neglected field for investigation which might lead to very important practical conclusions, which could be simply and inexpensively applied. What becomes of the energy dissipated in train resistance? So far as has yet been discovered, it is all re-converted into heat as a result of friction. There is no evidence of its conversion into electrical or other forms of energy. This heat is constantly radiated from the journal-boxes; or they would soon become red-hot. The rate of radiation is quite certainly as the difference between the internal and external temperatures, other things being equal. If then it can be shown what the actual differences in the temperature of the air and of the bearings are, at the end of a certain length of run, on a sufficient number of days and for a sufficient number of cars, and it should appear, as we suspect it would, that this difference was materially greater in cold weather than in warm, it would be a tolerably safe deduction that more energy was being destroyed to maintain this difference of temperature. Now it appears to be a fact that the effective hauling power of engines is 10 to 15 per cent. less in winter than in summer, and it is difficult to account for more than a part of this difference on the score of the different condition of the rails. As respects wind, contrary to a general impression, there is absolutely no difference, the average velocity of the wind being higher in the warmer than in the colder half of the year. It might well be, therefore, assuming the facts to prove as suggested, that a simple shield to preserve still air around the journal boxes would have a material effect to reduce the dissipation of energy necessary to keep the journal properly warm, and hence the winter train resistance; or that lubricants less affected by cold might have the same effect.

It would be a comparatively simple and inexpensive matter to observe the temperature of journals as trains come into the yard. All that would be necessary would be a few good thermometers, and time and patience to make the large number of observations which would no doubt be required to get a true average between widely varying individual observations; for they would be almost sure to thus vary. The coming winter will be a good time to make the cold half of such observations, and we trust some one may make them both in winter and summer.

AMERICANS are at last to have the enviable opportunity of subscribing to the "new issue" of Panama Canal bonds, if the late action of the American Committee is any warrant of their real intentions. This organization has shown very little activity in the past in seeking subscriptions to the Canal loans in this country;—fortunately for the investing class—but it now proposes to co-operate with the central committee in Paris, in its desperate efforts to raise more money. The 300 sub-committees scattered over France, and the most earnest pleading and most glittering promises of DE LESSEPS, seem only to prove that France is exhausted, as far as the Canal is concerned, and the Committee in its sore distress must seek strange fields and pastures new. But they should understand at the start that Americans will demand a much fuller and more intelligent rendering of account for the money already expended by them than any so-called statement yet presented to the French public. Mere promises "to open the Canal to traffic in 1890" will extract little money from Americans, and the wasteful methods, shiftless engineering and lack of plain common sense in the conduct of work, which has characterized the past administration at Panama and in Paris, will hardly encourage a heavy investment in the future of the Panama Canal. There is too much money already expended, and there are too many serious physical problems yet unsolved to ever make that route a commercial success on its present basis; and the wise Americans will abstain from any vested interest in "a scaling operation" which the French stockholders must very soon undergo if a canal of any kind is ever to be completed across the Isthmus at that point. Even the closing item of the press report, that "the latest news from the Isthmus was favorable to the enterprise" will prove an insufficient bait.

IN this issue we give the first of a series of extracts from the professional note-books of WILLIAM J. MCALPINE, one of the oldest of living American engineers, and a member of the profession of engineering who needs no introduction to our readers. These note-books cover a period of more than 40 years of active practice in America and abroad, and they are in themselves a monument of patient, conscientious labor in their record of the experience of their author and of others, in almost every branch of the profession he had chosen. Forty years ago text-books and treatises on engineering subjects were scarce, compared with the flood of such literature poured out annually upon the engineers of to-day, and it was only by the careful and immediate noting of such matters as were useful in practice that the older engineers were enabled to secure a record for future personal use. But the habit thus early formed, from necessity perhaps, has been kept up even to the present day by Mr. MCALPINE, and these books are full of data relating to modern works, particularly such matters as are of passing record in the daily press, and yet may form important links sometime in a chain of evidence wanted by the engineer. We promise no regular sequence, but shall present them from time to time under the heading of "Extracts from an Engineer's Note-books."

As an indication of what good steel rail of the old fashioned quality ought to stand, there was laid in 1871-2, on the New York, Pennsylvania & Ohio Railroad, 109.43 miles of Ebbw Vale and Dowlais steel. At the end of 1879, after sustaining about 15,000,000 tons in average trains of 400 tons, or after over 7 years of wear, there was left 109.24 miles, or practically all of it. At the present time there is still some 20 miles of this steel in use on main track after sustaining probably 50,000,000 tons in 17 years of service, and most of the remainder has been removed to put in side track, very little of it having been scrapped.

Where are the rails that will show such service now-a-days? They are not rolled. We doubt if there is a single 100 mile lot of rail 7 years old in any part of the country, under a traffic of 2,000,000 tons or over, which can show 99.8 per cent. of the rails still in service, yet the cost of manufacturing equally good rails to-day would probably be not more than $5 or $10 per ton more than the wretched stuff which is now usually sold as rails, and which, one may safely say, would be dear at half the price of the better article. The great lack is

an *effective* mode of preliminary inspection for physical qualities. If we had that, the quality of rails would speedily improve, but no one seems able to supply it.

THE Manitoba situation becomes daily more complicated. The Provincial Government announce that they will "appeal to the foot of the throne against the outrages perpetrated against the Province by the Federal Government", which means almost necessarily, if they are sustained, the elevation of the Province into a crown colony, and a dissolution of the loose bond by which they are connected with the other Provinces, which has little hold upon the affections of any of the Canadian colonies, and none at all, one may almost say, upon Manitoba, which is honeycombed with disaffection to the existing order of things.

As for the Canadian Pacific, their position in the matter is a perfectly intelligible one. It is a pure matter of business with them, to hold on to every advantage which the law gives them, and surrender it only for a consideration or from necessity. They have recently had $15,000,000 of bonds guaranteed for 50 years by the Dominion Government as a consideration for the surrender of the monopoly clause of their charter, but this clause says merely:

"For 20 years from the date hereof no line of railway shall be authorized by the Dominion Parliament [nor by any Province, by separate clause] to be constructed south of the Canadian Pacific Railway from any point at or near it, except such line as shall run southwest or west of southwest, nor to within 15 miles of lat. 49° [the boundary]."

The waiver of this clause, however, does not expressly carry with it the right to cross to C. P. tracks, and therefore the C. P. claims that that right must be secured, if at all, in the manner established in the "Consolidated Railway Act": *i. e.* by application to the Railway Committee of the Privy Council, after notice to the opposing company, and decision of all disputed points by arbitrators.

THIS position is logical enough, but the insistance on such a mere technical right indicates that it is expected to accomplish something more than delay by it from the Federal authorities; either a denial to the Province of the right to charter the opposing railway or some further cash consideration. That the best interests of the people of Manitoba, or of any other large community, requires that the Northern Pacific or any other railway which desires to compete for its traffic should be permitted to do so, until competition becomes overdone, is beyond dispute, and it will probably lead to serious consequences should the Dominion authorities attempt to forbid it, but the forms of law should first be complied with, and the C. P. would be very foolish to give up any stategic advantages which it may have from past concessions on contracts, without some consideration therefor. The outcome is difficult to foresee, except that this dispute must tend to strengthen the widespread dissatisfaction with their existing political status which exists in Manitoba.

OUR attention has been called to the fact that the article on a "Formula for the Computation of Railroad Earthwork", which appeared in our issue of July 28, was by accident not credited to its author, Mr. H. L. JOSEPH, C. E., of the Union Pacific Railway.

THE Baltimore & Ohio is unfortunate lately. As we go to press another head collision is reported due to a misplaced switch, over which the limited express dashed at full speed into a waiting freight train, killing 7 persons and causing a bad wreck.

An Error of Theory.

It is hard for engineers now-a-days, who find the theory of the strains in bridge trusses reduced to such simple and universally admitted elements, to understand how such an almost self-evident type of construction (as it now appears) as the Howe and Whipple trusses, for example, could have failed of recognition for so many years, during which engineers of undoubted distinction and ability were making all kinds of experiments, and were all more or less in the dark as to the true theory of bridge strains. It would be absurd to suppose that they were of any less ability or general knowledge than those who happened to hit on the true theory of construction; but all experience seems to indicate that even when the theory of a new type of construction is not very complex, it takes a certain time and the consensus of many minds to establish it on a firm and generally accepted footing.

The construction of high masonry dams on scientific principles of design is to-day in much the same position as was bridge construction 30 or 40 years ago; a comparatively new branch of engineering, in which the stock of accumulated experience is still very small, and in which, consequently, it is pardonable for any man to err, without any reflection upon his engineering knowledge or skill, any more than it is a reflection upon our early engineers that they did not at once discover and act upon the true theory of the strains in bridge trusses. Less than a dozen high masonry dams which can be said by any stretch of courtesy to have been designed, even in attempt, to secure a strictly scientific use of the material, as distinguished from the ignorant piling up of mass, can be said yet to exist; and of these the Furens, built in 1862-66, was the earliest of the gravity type, and by general admission is still the finest example. It is perhaps only a coincidence that the Zola, of the pure arch type, antedates all the gravity dams of scientific design by no less than 20 years, having been built in 1843, and hence being now 45 years old.

This is a very slim amount of experience to establish a theory of construction upon, and it is therefore from no lack of respect to the eminent engineers who composed the late Board of Experts on the Quaker Bridge Dam, whose report we published Nov. 3, that we maintain that they erred greatly in allowing and computing for an extra thickness for curved dams. This we do on grounds quite independent of any possible arch action in a curved dam, holding that their conclusion was reached only by neglecting certain considerations which can be readily and quickly pointed out, and when so pointed out, as we attempt to do below, must be generally admitted to be obvious and undeniable. If so, it will, or ought to, considerably modify their conclusions and recommendations; and certainly will radically modify their comparative estimates of cost, in connection with the strange errors of fact in those estimates which we pointed out in our issue of Nov. 3, for which the Board of Experts were not responsible, but which tended by an unfortunate coincidence to place curved dams as compared with straight, and short radius dams as compared with long radius, under a double disadvantage.

We feel the less hesitation in differing from the Board of Experts on the theoretical question, that they do not give any reasons in support of their conclusions but simply state:

"In comparing different locations of the dam, in order to discover the one which combined most effectively the advantages of economical construction and pleasing effect, we were confronted with the fact that *our calculations indicate that in a dam built upon a curved plan of large radius the bottom down stream toe-pressures are increased beyond those in a straight dam of the same section in consequence of the length of the toe being less than the length of the face to which the pressure of the water is applied.*" [Italics ours].

Certainly in the existing state of the art no man's or Board's mere dictum that "their calculations indicate" something which can be and is questioned should be accepted as conclusive, especially when to do so not only involves a considerable difference in the cost of the dam but almost certainly its radius and possibly its general location as well. We proceed to give, as briefly as may be, the reasons why we regard their conclusions as unsound, beginning from the foundation.

The problem is to maintain stability in every point in a dam, with a certain factor of safety, against a water pressure F, Fig. 1. Any point P, acted on by a force F, must be acted on likewise by a force F' (1) equal in magnitude, (2) opposite in direction and (3) passing through the same point; and it is by this simple and elementary relation of strains that the stability of a gravity dam is maintained.

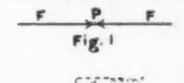


Fig. 1

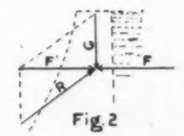


Fig. 2

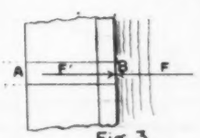


Fig. 3

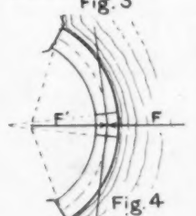


Fig. 4

Fig. 5

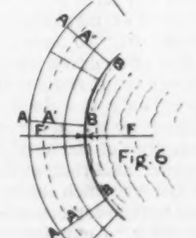


Fig. 6

The force F', Fig. 1, is not, it is true, in reality supplied by a single force, but by the resultant of two forces acting in a vertical plane: viz., gravity G, Fig. 2, and the reaction of the masonry R, but the resultant F' is horizontal, and as respects the horizontal plane the simple diagram of Fig. 1, amplified in Fig. 3, correctly represents the action of the forces on every point of a gravity dam.

Just as a single force may be supplied by two components in the vertical plane, so in theory it may be supplied by two components in the horizontal plane and it is so supplied in the dams of the pure archtype, which now exist, as shown in Fig. 4, which represents the forces acting on any stone or point of a dam of the pure arch type. The resultant F', to resist the force F, is obtained from two components T, Fig. 4, acting perpendicularly to the inclined faces of the voussoir.

It is claimed, however, and we believe with force and truth, by those who advocate straight dams rather than curved, that a dam whose equilibrium is primarily due to gravity, cannot to any large extent be maintained at the same time by arch action such as is outlined in Fig. 4; for the reason that, given the same resultant F', the force R, Fig. 2, is (1) much less in magnitude than the

arch thrust, and (2) acts through a much less mass of masonry, so that the gravity profile resists that horizontal yielding of the masonry which is absolutely necessary to generate the arch reactions *T*, Fig. 4, much as centering resists and forbids arch action in a vertical arch. We may support a load by an arch if we please, or we may support it directly, by props under the arch, but we cannot do both at once.

This argument has been pushed to unjustifiable extremes by denials that there was, therefore, no arch action whatever in a curved dam, or that it might not become of great importance in case of partial or complete failure of the gravity stability, but in its essential features, we repeat, and have never questioned, it is a strong and sound one.

But here comes in the fallacy to which we take exception. It appears to be assumed in the report of the Board of Experts that inasmuch as there can be little or no arch action proper, of the nature outlined in Fig. 4, therefore Fig. 5 outlines the proper manner of analyzing the strains in a curved gravity dam as compared with the straight dam, Fig. 3.

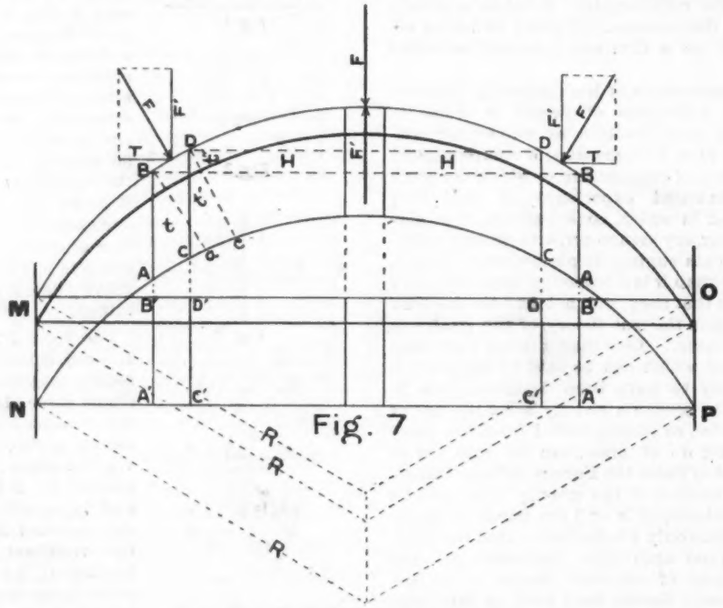


Fig. 7

Action of Strains in a Curved Dam.

To support each unit *B*, of the face of a straight dam, acted on by the force *F*, there is in plan the rectangle *A B* of masonry, of the same thickness throughout. To support the same unit *B*, of the face of a curved dam, Fig. 5, acted on by the same force *F*, normal to the face, there is in plan only the wedge-shaped mass *A B*, defined by radial lines drawn from the two extremities of the unit of face *B*, considerably narrower at *A* than at *B*. The pressure per square foot by which the reaction *R*, Fig. 2, is created is thus correspondingly increased, and in order to equalize it with that which exists on a straight dam it is alleged to be necessary to widen the base by some extra thickness *A A'*, so that the toe-pressures per square foot may remain the same.

It is even claimed by one of the members of the Board of Experts, if we have been correctly informed, that, apart from all questions of appearance, the form of dam which is theoretically most economical is a *concave* one, Fig. 6, instead of a convex or arched dam, because the area for resisting the toe-pressures is thus increased and consequently the dam may be made thinner by some distance *A A'*, and yet preserve the same toe-pressures per square foot. We do not envy the man who should incur the laughter of the engineering profession by seriously proposing to construct such a concave dam, but that is a logical corollary of the argument in favor of thickening the base of a convex dam; and if the argument be admitted, it was natural that a radius of 1,146 ft. should have been preferred to one of 900 ft. or less, and that each should have been loaded with an excess of cost due to what we are compelled to regard as an error of theory in addition to the errors of fact in the estimates.

The correct method of analyzing the strains in a curved dam is not, in our judgment, that of Figs. 5 and 6, but that of Fig. 7, which has no reference whatever to any possible arch action, and yet shows a curved dam of equal total volume, *and of smaller normal* (*i. e.* radial) *cross-section* to have greater stability than a straight dam, and no greater maximum foundation pressures.

Let *M N O P*, Fig. 7, be a straight dam, which is drawn, for simplicity, as if closing a rectangular opening. With any constant radius *R* strike arcs *B D D B*, *A C C A*, to which the corresponding face and rear lines of the straight dam are chords. Conceive each dam to be divided up into laminæ by parallel lines *A B*, *C D*; *A' B'*, *C' D'*; perpendicular to the face of the straight dam. Then will each of these laminæ be of equal volume in the two dams, and consequently a section of the curved dam normal to the face, instead of being of greater or even equal section, will be of smaller section. Nevertheless, it is the stronger dam, regardless of arch action.

Each lamina, *A B C D*, is acted on by a force *F* which is (1) larger than the face pressure on the corresponding lamina *B' D'* of the straight dam in the proportion of $\frac{B\,D}{B'\,D'}$, and (2) oblique in direction. The lamina therefore *tends to tip over sidewise*, and is in itself without stability, but the force *F* is not therefore resisted by the wedge-shaped lamina *B D ac*, with its axis in the same line as *F*, *for the reason that the tendency of the lamina A B C D to tip over is resisted by the adjacent laminæ*. From the fact of this lateral resistance the normal force *F* becomes resolved into two components *F'* *T*, at right angles to each other, *F'* being resisted by the reaction of the lamina *A B C D* acting as a gravity section, and *T* being resisted by the reaction of the mass *H*, also acting to some slight extent (which we will shortly consider) as a gravity dam-section of great mass; but for the most part, as in the cut, the mass *H H* does not act as a dam at all, but merely serves as a strut in which the two opposing resultants *T T* react against and destroy each other, so that the pressure never reaches the foundation at all.

Now comparing the magnitude of these forces with the masses which resist them, we have geometrically, remembering that the water pressure per unit of face area is the same:

Force *F*: force *F'* : : *B D*: *B' D'* = *t*

t being the thickness of the equal lamina, *A B C D*, *A' B' C' D'*.

Designating the thickness of the mass *H* by *t''* we have likewise:

Force *F*: force *T* : : *B D* : *t''*

In other words, the component *F'* is the same in magnitude and direction as that due to the pressure on an equal lamina *B' D' A' C'* of a straight dam, and since the areas *B D A C* and *B' D' A' C'* are likewise equal in all horizontal sections, we have precisely equal and similar toe pressures on the line *A C*, and at all other points.

The chord pressures *T* (as we may term them) acting parallel with the chord line, in so far as they react against, and destroy each other in the mass of masonry *H*, create additional strains within the mass, but these are a positive benefit, since they are at right angles to the main strains and simply throw pressure on all six faces of each cube within the mass, which will enable it to sustain a larger pressure, if anything, than if the pressures were in one plane only, and also throw the whole face of the dam into compression, eliminating cracks and effects of unequal settlement, and preparing the dam to act as a true arch in case of need; as it must to some extent in any case, both because the mass will yield elastically and because *the effect of the forces T is to make the dam more convex*, which is resisted by arch action, the latter tending to make the curve flatter. We judge it to be demonstrable that about 10 per cent. of the total strain is likely to be thus sustained by arch action, and hence that the curved dam should be made proportionately thinner than the straight for equal strength, or credited with this excess of strength, although in this discussion we neglect wholly such arch action.

In a dam precisely similar to Fig. 7, closing a rectangular opening, there would be a certain considerable part of the face (toward the ends *M O*) where the chord pressures *T* could not be resisted by the masonry acting as a strut, but where the mass *H H* would act merely as a gravity dam of large section. The resulting strains could under no circumstances and in no part of the dam do harm (but rather good) within the mass of the dam itself, for the reason that they are at right angles to the main strains, until the resultant *T* became greater than *F'*; but it is obvious that the intensity of the foundation toe pressures would be increased along the line *N A C*. Right here therefore we need to remember that *the part N A C does not exist* in the proposed dam, nor in any actual dam. Rather, the toe of the dam lies on a chord line *M O*, the plan of the actual dam being almost identically the theoretical diagram which we used in our first discussion of Feb. 4, reproduced in Fig. 13, as may be seen from the dotted ground plan in Fig. 12, reproduced from our issue of Feb. 3.

Let the reader take this dotted ground plan and, neglecting the low extension to the left which is common to both it and the straight

dam, and is a gravity dam by itself, draw lines across the plan parallel with a tangent to the face at the highest part of the dam. These lines will represent the direction of the forces

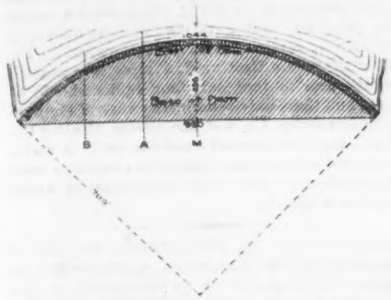


Fig. 13.—"Curved" Dam (with curved crest and straight toe) across the same valley, *and of the same cubic volume as a "Straight" Dam.*

T, Fig. 7, and it will be seen that without exception these forces, *T*, either—

1. React against and destroy each other within the mass, acting as a strut; or

2. In part so react against and destroy each other, and in part create a slight downward resultant resisted by the *interior* of the foundation, where it is (*a*) less strained than at the toe, and (*b*) far better able to safely sustain pressure; or

3. Toward the ends of the dam, where the forces *T* might otherwise throw an increased pressure on the toe of the foundation, the force *T* is (*a*) very small, because the water is shallow, and (*b*) absorbed at once, by increased pressure upon the foundations of the low extreme ends of the dam, where the foundation pressures are so greatly less (see diagrams from Board of Experts' report, published Nov. 3) that many times the additional pressure which could come from this cause would still leave the pressures low.

By no possible ingenuity can it be shown that any pressure arising from the thrust *T* can cause at any point an increase above the established maximum pressure. At every point it comes under one or the other of the above three classes; and hence it follows that the curved dam, instead of requiring to be of a thicker normal cross-section than the straight, as the Board of Experts make it (6.7 per cent.) or even needing to be made as thick, requires only to be of equal thickness *on a plan perpendicular to the chord line*, which means a further difference of about 10 per cent. in its volume, or in the proportion of the chord line to the curved axis of the mass.

When we add to these two sources of error in the comparison, that even the comparative masses as fixed by the Board of Experts were loaded without rhyme or reason with a further excess of 8 to 15 per cent. by some very extraordinary errors in computation for which no defense is attempted;—it will be seen how strong must have been the argument in favor of a curved dam to have led the Board of Experts to recommend it nevertheless. When these errors are all corrected, however, as we certainly trust they will be, we regard it as quite certain that a shorter radius than that selected by them will appear preferable; and as highly probable that a location further down stream will likewise appear wise.

To sum up the argument as to strains in a popular way, readily comprehended: Let us turn our dam up on end in the form of a vertical arch, Fig. 8, with the action of the strains in which we are all more familiar, and let us place our load of water on top of the dam-arch instead of in front of it.

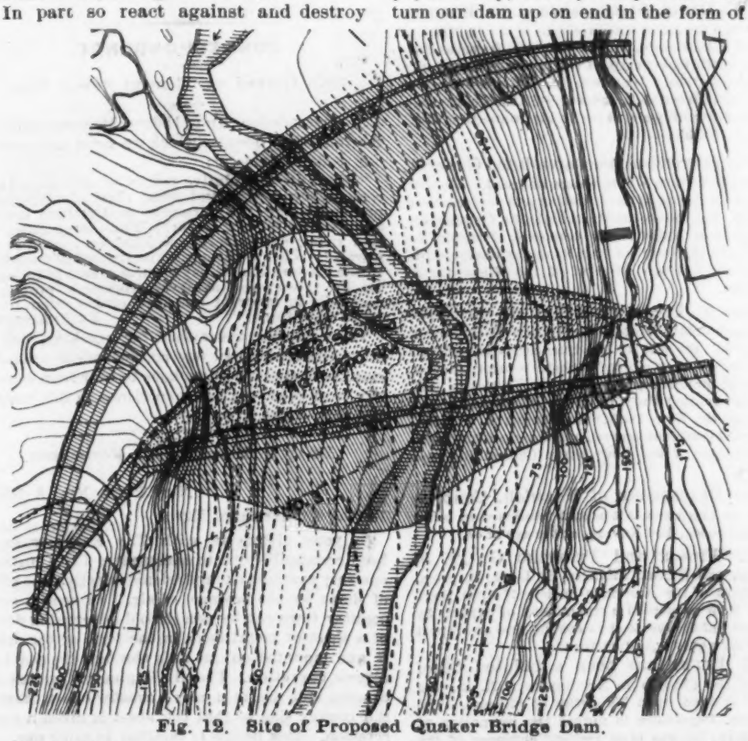
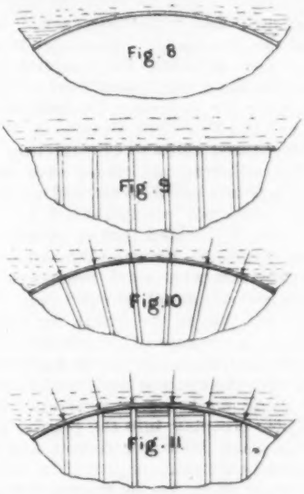


Fig. 12. Site of Proposed Quaker Bridge Dam.

Say the opponents of the curved form: "You cannot make such an arch (Fig. 8), not only because the span is too great, but because one side of your arch must be, as it were, held up by centering, from the friction of the mass on the bottom." This argument we have said to be good in its substance, although pushed too far.

It is then claimed that as we cannot have an arch (Fig. 8), we may as well have a straight face and support it directly by parallel props (Fig. 9), the parallel props being the gravity action of the masonry. It is plausibly urged that we cannot set up parallel props to support the arched form, (Fig. 8), for the reason that the oblique pressures would tend to tip them over, and hence that props (gravity action) if used at all to support a curved face, must be put in radially to that face (Fig. 10), thus concentrating a greater pressure on the foundation, and requiring correspondingly greater bearing area.

To this we answer "No: the curved face likewise may be supported by parallel vertical props without increasing the strain on them, by putting in horizontal struts to resist the oblique or horizontal thrust (Fig. 11) and when



the vertical struts must be put in so close together as to touch each other, as they must be in either Fig. 9 or Fig. 11 to sustain the load, the verticals themselves will act as horizontal struts, not only without decrease but with positive increase of their ability to sustain the vertical load, which is the same in either case."

We submit this position with confidence to the judgment of the profession. The particular plan which may be adopted for the Quaker Bridge Dam is nothing to us, and perhaps our readers, like ourselves, have had about enough of it; but we have felt it a duty which we owed to engineering to do what we can to put the treatment of the problem, in professional literature at least, on a sound foundation. We do not expect to be entirely successful in this. The future seeker after light will naturally seek it in the official reports of those charged with the design of the greatest dam yet built, rather than in the casual discussions of a technical weekly. He will not find those reports entirely in consonance with each other, it is true, for the late Board of Experts have agreed with most of the criticisms which we originally made (Feb. 4, etc.) on the first designs; and have proposed a plan with which there is but little fault to find; but he will be all the more disposed to believe that in those points in which the two reports agree they are correct. Nevertheless, we submit to the judgment of the profession that as respects the question discussed herein, they are both incorrect

A Trunk Line War.

The map and editorial review of the Trunk line railway systems, which we published in our last issue, is of especial interest just now, in view of the fact that the past week has been marked by the formal opening of what may possibly become the most serious war of competition among these systems which has occurred for years. Ever since the enactment of the interstate commerce law, with its prohibition of pooling, the task of keeping up even the semblance of harmonious action among the members of the Trunk Line Traffic Association has grown more and more difficult.

The war in dressed beef rates which occur-

red last summer, when rates were put down from 65 cts. to 6 cts., brought about a similar demoralization in live stock and provision rates. These troubles, however, had been patched up, and with the close of navigation and the cessation of water competition it was expected that rates were to be advanced so that a paying business could be done through the winter months and something earned with which to pay dividends. Passenger traffic, however, was involved in complications. Some months ago a war was started in immigrant rates by the Delaware, Lackawanna & Western and the New York, Ontario & Western, which reduced rates to Chicago from $13 to $5. Proportionate reductions were made on tickets to points farther west, and as these reductions were not countenanced by the Western roads, it is stated that at present on immigrant traffic to Kansas City and other Missouri river points the total receipts of the trunk lines are only about $2 per head. Add to this the fact that in the hustle for traffic, commissions on the sale of tickets are being paid in some instances it is said as high as $5, on Kansas City tickets, and the loss of revenue which is going on becomes apparent. The trouble is also creeping into the regular first and second class passenger tickets, and the end is evidently not yet.

But the event which has set the whole trunk line caldron seething occurred on Nov. 11, when the Vanderbilt lines announced a cut in west bound freight rates from New York to Chicago of about 33⅓ per cent., a reduction which was met at once by every line on the list. What makes the situation serious, however, compared with all that has preceded, is the fact that the warfare is no longer waged by the weaker lines to secure their differentials, but seems likely to be a fight between the Vanderbilt and the Pennsylvania systems. And when these Greeks prepare for the fray, it is well for small contestants to stand from under. When the famous West Shore deal was concluded, it was supposed that peace between the two great rivals for the trunk line traffic was finally secured. It is understood that one of the conditions of this peace was the abandonment of the South Pennsylvania enterprise; but the sale of this to the Pennsylvania was never consummated on account of legal difficulties, and the VANDERBILTS now hold this and the Pittsburg & Lake Erie over the head of their rival. There is little doubt that if a war should be once inaugurated, the South Penn. will be finished as fast as men and money can do it, and used for all it is worth as a weapon in the fight.

Compared with this prospective fray, the amusement which the lines west of Chicago have indulged in during the summer and fall of carrying traffic at less than cost, is mere child's play. It is to be remembered that when the last great trunk line war occurred in 1884, there was no interstate commerce law to prevent the roads from making up their losses on through traffic by raising local rates. Under present conditions, then, the effect of an all around warfare of unchecked competition upon the finances of the companies is certain to be worse than anything before known; just how bad, it is to be hoped we shall not at present know.

PERSONAL.

GEO. H. FORSTER, President of the New York Board of Aldermen, died Nov. 8.

W. H. CANNIFF, of Hillsdale, Mich., Superintendent of the Lansing, Ypsilanti and Fort Wayne branches of the Lake Shore & Michigan Southern, has been appointed Assistant General Superintendent of the system.

O. F. BALSTON has been appointed Chief Engineer of the Kings County Elevated Railway, Brooklyn, N. Y., vice ANDREW BRYSON resigned. Mr. BALSTON was formerly Division Engineer.

TRACY W. NILES, train dispatcher of the Lake Shore & Michigan Southern at Buffalo, N. Y., has been appointed Superintendent of the Kalamazoo division.

A. M. MOSIER has been appointed Superintendent of the Western division of the New York, Pennsylvania & Ohio, with office at Galion, O., vice J. C. MORELAND, promoted.

NELSON C. THRALL, has been appointed Assistant to President T. F. OAKES, of the Northern Pacific, and in the absence of the president Mr. THRALL's approval will be necessary upon all requisitions, pay rolls and vouchers.

C. B. COLE, of Tacoma, Wash. Ty., has resigned his position as Division Superintendent of the Northern Pacific.

J. W. SCOTT, formerly of the Pennsylvania Central, and recently of the Atlantic & Pacific, has been appointed to succeed F. P. WEYMOUTH, as Superintendent of the Idaho Division of the Northern Pacific.

H. P. STONE has been appointed Second Vice President of the Chicago, Burlington & Quincy system. E. P. RIPLEY succeeds Mr. STONE as General Manager of the lines east of the Missouri river.

JOHN W. DAVIS, first assistant to ROBERT GARRETT, when the latter was President of the Baltimore & Ohio, died at Baltimore, Md., Nov. 8. Mr. DAVIS at the time of his death had charge of the tax department of the Baltimore & Ohio. He was 65 years of age, was well known among railroad men, and was with the Pennsylvania for a number of years prior to his connection with the Baltimore & Ohio.

M. J. CARPENTER has been appointed General Manager of the Duluth & Iron Range Railroad. He will have immediate charge of the operating and construction departments. For the last twelve months Mr. CARPENTER has been General Agent of this company. Previous to his service with the Duluth & Iron Range he was Superintendent of the Chicago Division of the Minnesota & Northwestern.

FREDERIC A. POTTS, President of the New York, Susquehanna & Western, died in New York, Nov. 9, at the age of 53. He was at one time active in political affairs, and in 1874 was elected a State senator in New Jersey, but he practically retired from politics in 1880, when he reorganized the New Jersey Midland Railroad, which became the New York, Susquehanna & Western. He was elected President, and remained so until his death. He was a Director of the New Jersey Central Railroad prior to 1880.

LORENZO BLACKSTONE, of Norwich, Conn., a director of the Chicago & Alton, and interested in other Northwestern roads, died Nov. 14, at the age of 69.

JOS. M. WILSON and FREDERIC GRAFF, of Philadelphia, and HENRY FLAD, of St. Louis, all prominent members of the American Society of Civil Engineers, have been appointed a commission of experts by the Congressional Committee to examine into and report upon the Washington aqueduct frauds.

JOHN E. BLUNT has been appointed Chief Engineer of the Chicago & Northwestern R. R., and has already entered upon his duties at Chicago. The Winona, Minn. *Republican* in noting the promotion of Mr. BLUNT says: He has been resident engineer of the Winona and St. Peter and Dakota Central divisions for several years, discharging his duties with marked ability and fidelity, and his promotion now is but a fitting reward for his faithful service. He has been universally esteemed by the business men of Winona, whose good wishes will go with him to his new field of labor."

NEW YORK SUBWAYS READY FOR USE.—Secretary Moss, of the Board of Electrical Control, furnished on Nov. 13, a list of telephone and telegraph subways ready for use Nov. 12. Here are the locations

Broadway, Bowling Green to Fifty-ninth St.
Sixth Av., Fourth to Fifty-ninth St.
Madison Av., Twenty-third to Fifty-ninth St.
Lexington Av., Fifty-ninth to Sixty-fifth St.
Fifty-eighth St., Third to Eighth Av.
Forty-eighth St., Vanderbilt Av., to Sixth Av.
Forty-fifth St., Sixth to Eighth Av. Building.
Forty-second St., Madison Av. to Broadway.
Thirty-eighth St., Lexington to Eighth Av.
Twenty-third St., Fifth to Sixth Av.
Eighteenth St., Third to Sixth Av.

This list of electric light subways also ready for occupancy on same date was given:

Broadway, Fourteenth to Fifty-ninth St.
Sixth Av., Twenty-fifth to Fifty-ninth St.
Forty-second St., Fifth Av. to Broadway.
Twenty-third St., Fifth to Sixth Av.
Twenty-fourth, Twenty-fifth, Twenty-sixth, Twenty-seventh, Twenty-eighth, Twenty-ninth, Thirtieth and Thirty-first Sts., Broadway to Sixth Av.

The application of the Western Union Telegraph Co. for permission to string seven 50-wire cables along Broadway and Park row, in consequence of their subway service having been impaired by the leaks of the Steam Heating Co.s' pipes, was granted with the proviso that only four cables should be strung, and those only pending the work of the Subway Construction Co. and the Steam Heating Co. to make the underground conduits safe. A notice was ordered issued to all companies owning or operating conductors that their wires must be under ground in 90 days.

HOUSE-BUILDING IN PHILADELPHIA for the 10 months ending Oct. 31 shows an aggregate of 5,589 separate dwellings erected or commenced in that time. This is an increase of 1,020 houses over the same period in 1887. With an average of 5 persons to a household, this means a city of over 25,000 inhabitants, or at least the means of housing that number, built in less than one year. It also means light and air and comparative comfort to the poor, in striking contrast with the tenement-house hordes of New York and some other cities.

CORRESPONDENCE.

Salt Glazed vs. Cement Sewer Pipe.

A correspondent from Helena, Montana, sends us the following queries, which we must ask some of our readers to answer:

"What are the relative merits of salt-glazed and cement sewer pipe, and what class of material is preferable for the former? Is Portland cement always used for the latter? What large cities are now using extensively one kind or the other for sewers? What is the approximate cost of each kind in the Eastern States, say anywhere east of Chicago? Do the most noted sanitary engineers pronounce decidedly in favor of one kind or the other, under usual conditions?" EX ENGINEER.

These queries are rather far reaching, but as other engineers than our correspondent are interested in the questions, we hope to hear from some of our readers having late experience in this matter. ED. ENG. NEWS.

Effect of Form on Air Resistance.

NEW YORK, Nov. 8, 1888.

EDITOR ENGINEERING NEWS:

In your discussion with *The Engineer* as to head resistances due to atmosphere I can instance one very common example demonstrating the effect of shape on the passage of air. In nearly every country town can be seen the old advertising device of a sheet of metal bent in the form of the letter *S* and mounted on an axis through the point of reverse curvature. The air impinging against the concave side exerts a much greater effect than on the convex side so that the sheet is given a rapid rotation. This device is familiar to every one.

Yours truly,
WM. BARCLAY PARSONS.

The Aqueduct Tunnel Excavation.

Cumberland Railroad and Coal Co.
SPRING HILL, N. S., Oct. 27, 1888.

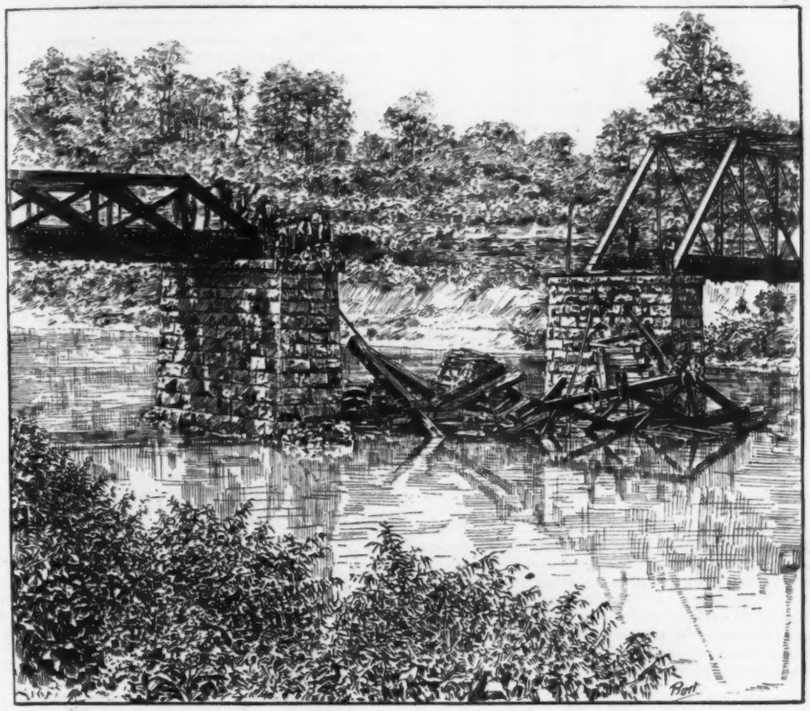
EDITOR ENGINEERING NEWS:

In reference to the discussion at present going on in your paper respecting the excavation of rock outside the neat section of the New Aqueduct tunnel. I beg to call your attention to a section in Trautwine (edition 1882) pages 626-7 where he says; "since the sides and roof are rough as blasted, the width and height should be estimated to the contractor as about 18 ins. or 2 ft. greater than the established *clear* ones. At any rate the mode of measurement should be clearly stated in the specifications for the work".

R. W. LEONARD.

[The mode of measurement was clearly stated in the specifications. Besides which, even authors of Mr. TRAUTWINE's undoubted ability and experience are liable to fall into error, and in estimating tunnel or any other kind of rock excavation, it is not customary t' esti-

mate beyond the specified neat cross-section lines because of the necessary excess at points in order to obtain it. With unexpected and unavoidable falls and slips in either tunnel or other rock or earth excavation it is different; payment for them may be demanded and obtained in the absence of express stipulation to the contrary, but in this case there were such express stipulations, even against such accidents. ED. ENG. NEWS.]



A Small Bridge Failure; Baltimore & Ohio Railroad.

A Small Bridge Failure.

ALBANY, N. Y., Aug. 8, 1888.

EDITOR ENGINEERING NEWS:

I enclose herewith a view of the bridge on the Baltimore & Ohio Railroad over the West Youghiogheny river near Connellsville, Pa., which broke down on Aug. 2. It was a Howe truss bridge, apparently about 60 ft. span, and gave way suddenly under a light switching engine and an ordinary box car loaded with coke. Five men went down with it, but none were killed. Local papers ascribe rotten timbers as the cause of the wreck, though the bridge was said to have been recently inspected and pronounced all right. Yours truly,

CHAS. F. STOWELL.

[We reproduce the photograph as a rather instructive example of the bad effect of building spans of such length, trusting all to the integrity of the single stick in the chords, and especially to a notch in the end of the chord to hold the main brace, as we presume there was in this bridge since there was nothing else to take the thrust of the main brace, although the notch does not show either in our cut or the photograph. It will be observed (more distinctly in the unbroken than the broken truss) that a packing block had been inserted to take the thrust of the second brace, apparently as an after thought, and thus add to the strain on the main brace. Precisely where the first break occurred does not appear, but from the wreck we infer in the further truss at the nearer end.—ED. ENG. NEWS.]

SOCIETY PROCEEDINGS.

Engineers' Club of Philadelphia.—The regular meeting was held Nov. 3; Vice-President JOHN T. BOYD in the chair; 24 members and 3 visitors present. Mr. HENRY M. SPERRY presented a paper, illustrated by model, on "The Details of Interlocking Switches and Signals." Signalling can be divided into two branches, block signalling and interlocking. The absolute and the permissive block systems are used on the Pennsylvania Railroad; the former is the best, as it insures a definite distance between trains at all times. The automatic pneumatic block system, operated by the train and requiring no operators, has been successfully operated for a short distance on the Pittsburg Division. The interlocking system, in addition to its safety features, is a great labor-saving device, as one man can readily do the work of two or more, by its concentration of levers, and he is compelled by the locking mechanism to correctly set the switches of the various routes before he can clear his signals. Four styles of interlocking machines are now made in the United States, and at least three times this number in England. The first machine in this country was put up in 1875, at East Newark, on the New York Division of the Pennsylvania Railroad, and is still giving good service. The semaphore signal is operated in three ways, by one wire, two wires, and by pipe. Facing point switches should be avoided, except when interlocked, or at least provided with distant switch signals. A device is now being tried to operate the switch and facing point lock with one lever.

Prof. C. HERSCHEL KOYL, visitor, followed with an illustrated description of his Parabolic Semaphore, which to a front view presents the dimensions 5 ft. 6 ins. in length from the axis to the end of the blade, 11 ins. in width, and has a reflector 4 ins. wide along the centre from end to end; it is mounted in the ordinary casting which supports the semaphore arm, and rotates about the axis in the post, which is also the axis of the paraboloid, in the focus of which the lamp is placed. The light sent down the track from the arm is diverged sufficiently to cover curves in the road by slightly corrugating the reflector at right angles to the directions in which the divergence is required. "As, however, a red light has always been the danger signal at night, it is deemed advisable to still combine it with the position signal, and the result is accomplished, in this case, by making the upper part of the lamp red and the lower part clear or green, so that the arm, when horizontal, appears red and, when dropped white or green, as the case may be."

The Secretary exhibited, for Mr. GAYLORD THOMPSON, 15 photographs of work in progress on the New Croton Aqueduct.

At the request of M. DA COSTA, Brazilian Chargé d' Affaires, Prof. L. M. HAUPT presented a description of the plans proposed by M. CALAND, of Holland, for the improvement of the bar at the mouth of the Rio Grande do Sul in Brazil, by the usual jetties in pairs. The total length was 5 miles and the estimated cost nearly $6,000,000 without dredging. Prof. HAUPT described the physical features of the site, stated the importance of opening the ports of Brazil, and the attempts to do so by American and foreign engineers, and concluded that the jetty system would not be successful in such cases, where the channel was dependent upon the tidal scour from the Lagune dos Patos, which must be filled from the sea by a free admission of the flood tide. He then suggested that a sand and a wave barrier of a crescent form, resting on the bar in such a position as to defend the main ebb channel from the encroachments of the bar, conserving the energy of the ebb discharge and affording a free ingress of the flood-tide, would best fulfill the required conditions and at a cost of less than one-half that proposed.

HOWARD MURPHY,
Secretary and Treasurer.

Engineers' Club of Cincinnati.—The sixth regular monthly meeting of the Club was held Nov. 7. One member was elected, increasing the Club membership to 68.

Col. WM. E. MERRILL read a paper on "Movable Dams in General and the Davis Island Dam and Lock." He briefly defined movable or adjustable dams as those which can be lowered during high stages of water and raised into position again when the supply of water is so small as to require pooling to serve the purposes of navigation. Of various French systems of movable dams, those of Poirée and Chanoine are the only ones that can be used for the parts of movable dams that close the navigable channel, and of these the Chanoine system is much preferable for wide rivers, on account of the great amount of labor required to handle the "needles" of a Poirée dam. In the systems of Desfontaines and Girard the dam is easily raised or lowered by utilizing hydraulic pressure, but they can only be used on the weirs or high parts of movable dams where boats do not go. The hydrostatic pressure is obtained from the difference of level caused by the closure of the navigable pass. In the Desfontaines system of dam wickets, the pressure acts directly on the lower half of the wicket. In the Girard system it actuates a turbine working a pump, connected with a hydraulic jack in the rear of each wicket. He also described the American "bear trap", which utilizes hydraulic pressure and is much used in lumbering regions to pass lumber down stream on artificial waves.

On Davis Island, in the Ohio river, 5 miles below Pittsburgh, Col. MERRILL has constructed a movable dam in four sections, having an aggregate length of 1,223 ft., on a modification of the Chanoine system. In the ordinary system the wickets are dropped on the bed of the river by means of a tripper which pushes the props from their seats. It is quite difficult to manage long trippers on the bed of a river, and the greatest length of tripper thus far used is 125 ft.; as trippers are worked from both sides of an opening, it follows that the greatest opening for navigation on the Chanoine system thus far used is 250 ft. This is insufficient for Ohio river navigation and Col. MERRILL proposed to try trippers 200 ft. long, giving a navigable pass 400 ft. wide. This plan was afterwards abandoned in favor of a modification of the Chanoine prop seat or burter invented by M. PASQUEAU, whereby trippers are done away with and each wicket is handled regardless of its neighbors. This change caused the middle pass to be increased to 539 ft., which is the maximum that the river at that point would permit. Although this dam has been in successful operation for three years, the exceptionally large quantity of drift wood and occasionally of ice in this part of the river, has given so much trouble that a "bear trap" is now under construction in the middle of the dam to give an opening for the passage of the drift and ice, and it is proposed to replace the Pasqueau hurters on the weirs by Chanoine trippers, so that the weirs may be opened in case of necessity without leaving the service bridge standing to catch drift and ice. The lock rendered necessary by this dam is 110 ft. wide to allow the passage of four coal barges abreast. Its length is 600 ft. between gates. The ordinary mitre gates being deemed inapplicable to a lock of such great width, the lock is closed at either end by a single gate 114 ft. long. These gates are operated by steam, moving on rollers into recesses in the landward wall of the lock. There are 14 filling culverts, each 54 ins. diameter and closed by a circular balanced valve on a vertical axis, half in the river wall and half in the upper gate recess. The lock is emptied by seven 54-in. culverts in the lower gate recess and fourteen 36-in. openings in the lower gate. The last are operated by hand; all the rest by hydraulic pressure. The lock can receive at one time a tow boat, 10 coal barges, and 2 fuel flats, while 6 passenger steamboats can be locked through at one lockage.

RUSSELL HINMAN, *Secretary.*

[The details of the construction of the Davis Island lock and dam were given in ENGINEERING NEWS, May 15 and 29, 1886.]

Engineer's Club of St. Louis, Mo.—The following is the list of papers to be presented during the presen

The Weather of the United States for the Month of October, 1888.

(As respects the elements of most interest to engineers.)

According to special returns from the Chief Signal Officer of the U. S. Army.

STATIONS.	Temperature. Degrees Fah.				Wind velocity. Miles per hour.			Precipitation. Rain and melted snow. Inches.		
	Average	Max.	Min.	Range.	Average.	Max.	Direction at time of Max Vel.	Total.	Heaviest in 24 hours.	No. rainy days.
Northern Cities.										
Northfield, Vt	38.0	61.5	22.5	39.0	8.7	42	N	3.53	0.83	17
Portland, Me	43.3	61.0	28.8	32.2	7.7	29	NW	7.47	2.05	15
New York City	49.2	68.7	34.9	33.8	10.9	50	W	4.14	1.88	15
Pittsburg, Pa	49.0	73.8	32.7	41.1	6.3	29	NW	3.46	0.69	18
Chicago, Ill	48.4	76.3	31.5	44.8	11.0	34	SW	2.95	1.31	11
Omaha, Neb	48.4	80.2	28.2	52	6.9	28	NW	1.16	0.44	3
St. Paul, Minn	43.1	75.4	27.7	47.7	5.3	26	W	1.10	0.77	9
Duluth, Minn	42.2	73.	27.2	45.8	6.7	24	NW, E & NE	1.68	0.99	7
Bismarck, Dak	40.0	79.	20	59	9.5	80	NW	1.02	0.27	9
Average	44.6	72.1	28.2	43.9	8.1	34.7		2.95	1.03	11.6
Southern Cities.										
Washington City	60.0	75	35	40	4.1	24	NW	3.27	1.02	16
Louisville, Ky	52.5	77.4	32.5	44.9	5.6	24	W & SW	2.84	0.64	14
St. Louis, Mo	52.7	85.2	36	49.2	10	36	SW, W & S	2.59	0.76	9
Savannah, Ga	63.5	82.3	49	33.3	6.3	50	NE	6.81	2.77	12
Leavenworth, Kan	51.0	85.8	32.1	53.7	6.4	36	SW	2.60	1.40	6
Jacksonville, Fla	67.5	85	49.9	36.1	4.4	38	N	6.00	2.40	10
Chattanooga, Tenn	55.2	82.2	36.6	45.6	5.2	23	SW	5.17	2.51	13
New Orleans, La	67.9	87	54.7	32.3	7.2	36	W	7.36	4.13	7
Memphis, Tenn	57.0	83	40	43	5	24	SW	3.51	1.37	10
Palestine, Tex	65.4	90.2	36.7	53.5	5.6	22	S	1.51	0.66	6
Average	58.3	83.4	40.2	43.2	6.0	31.3		4.17	1.77	10.3
Western Cities.										
Helena, Mont	47.0	75	21	54	7.7	36	SW	0.14	0.04	11
Port Angeles, W. T	55.7	77.4	38	39.4	3.9	24	W	0.72	0.55	6
San Francisco, Cal	58.6	86.8	49.5	37.3	7.7	32	N	0.13	0.05	4
Salt Lake City, U	54.0	78.2	31.5	46.7	4.8	25	S	0.80	0.23	7
Denver, Col	48.4	79.8	26	53.8	6.3	36	NW	0.77	0.50	4
Yuma, Ariz	73.9	105.1	49	56.1	4.6	30	S	0.99	0.74	3
Santa Fé, N.M	48.4	72.3	29.5	42.8	6.1	28	W	1.40	0.91	5
Average	55.1	82.1	34.9	47.2	5.9	30.1		0.71	0.43	5.7

session, Dec. 5; Annual meeting. Reports of officers and committees. "Condensers for Steam Engines", Prof. J. H. KINEALY.—Dec. 19; Address of retiring President, M. L. HOLMAN. "Changing the Gauge of the Ohio & Mississippi Ry.", ISAAC H. SMITH, Manager, St. Louis Transfer Ry. — January 2, 1889; "The Interlocking System of the St. Louis Bridge & Tunnel Railroad", N. W. EAYRS, C. E., St. Louis Bridge Co. "A New Power Drill for Quarries and Mines, with Notes on Mining in Colorado", J. A. OCKERSON.—Jan. 16; "Wrought Iron and Steel Eyebars", CARL GAYLER. "A Burr Truss", Prof. E. A. PHILLIPS.—Feb. 6; "Rainfall and River Discharge in the Mississippi Valley", Prof. F. E. NIPHER. "Adding Machines", N. W. PERKINS, JR. — Feb. 20; "Elevated Railroads", GEO. H. PEGRAM. "Tests of, and Specifications for, Cast Iron", Prof. J. B. JOHNSON.—March 6; "Shortage on Coal in Car Lots", THOS. D. MILLER. "Improving the Channel of the Mississippi", WINSLOW ALLDERDICE.—March 20; "Street Car Running Gear", B. F. CROW; "Some Reminiscences in Connection with the Construction of the Union Pacific Railroad", C. H. SHARMAN.—April 3; "The Boiler for Use at Coal Mines", LEWIS STOCKETT. "Steam Plants for Electrical Service", WM. H. BRYAN.—April 17; "The Sanitary Condition of the Water Supply of New York City", Prof. C. C. BROWN. "Easement Curves, Missouri Pacific Ry.", WILLARD BEAHAN.—May 1; "Some New Theories and Experiments on Boiler and Factory Chimnies", Prof. H. B. GALE: "Experiments on Settling Water", JAS. A. SEDDON.—May 15; "The Trussing of the Fagin Building against Wind Pressure", Prof. J. B JOHNSON. "Fireproof Flooring", P. M. BRUNER.—June 5; "The Olive St. Cable Line" W. BARTLETT. "Compound Engines", E. E. FURNEY.

Engineers' Club of Kansas City, Mo.—A regular meeting was held Nov. 5.: President W. B. KNIGHT in the chair, and 10 members and 9 visitors present.

W. H. BREITHAUPT read for the committee on Highway Bridge Reform the draft of a law prepared to be presented with a memorial to the State legislature. Many of the other local societies had given the subject favorable attention, and it was expected that a final report would be submitted in one or two months.

A paper on "Electric Railways" was read by T. F. WYNN and discussed by those present.

KENNETH ALLEN,
Secretary

Canadian Society of Civil Engineers.—A meeting was held Nov. 8 at McGill College, Montreal. Mr. KENNEDY, member of the council, in the chair. Mr. RUST read a paper on the "Toronto Sewerage System", written by him expressly for the benefit of the students, and for which he was cordially tendered a vote of thanks. After an exhaustive debate on the modes of working described in the paper, the society adourned till November 22.

Engineers' Society of Western Pennsylvania.—At the meeting of the Society at Pittsburg, Pa., on Nov. 20, JOHN A. BRASHEAR will give a familiar talk on the subject of "The Status of Astronomical Engineering in Europe." The talk will embody the personal experience of Mr. Brashear in his late trip to Europe. He will also exhibit a new form of solar and stellar spectroscope recently invented by him.

Master Car-Builders' Association.—The following is a list of subjects, with the Committees appointed to report thereon, for the Annual Convention of the Master Car-Builders' Association, to be held June, 1889.

1.—"To Formulate a Code of Rules for the Interchange of Passenger Cars, including Sleeping, Parlor, Chair, Baggage and Express Cars." T. A. BISSELL, Wagner Palace Car Company, Buffalo, N. Y., JOHN W. CLOUD, New York, Lake Erie & Western, Buffalo, N. Y., EUGENE CHAMBERLAIN, New York Central & Hudson River, East Buffalo, N. Y.

2.—"Standard Journal-box Lid for a 60,000 lb. car and a Standard Lid for a 40,000-lb. car", J. W. MARDEN, Fitchburg R. R., Boston, Mass., WM. MCWOOD, Grand Trunk, Montreal, Canada, L. PACKARD, New York Central & Hudson River, West Albany, N. Y.

3.—"Standard Brake Gear for Air-Brake Cars, with a Brake Shoe for Iron Beam", E. B. WALL, Pittsburg, Cincinnati & St. Louis, Columbus, O., GEORGE HACKNEY Atchison, Topeka & Santa Fé, Topeka, Kan., GODFREY W. RHODES, Chicago, Burlington & Quincy, Aurora, Ill.

4.—"Journal Lubrication and Best Practice for Economizing Oil"; JOHN W. CLOUD, New York, Lake Erie & Western, Buffalo, N. Y., H. ROBERTS, Chicago & Grand Trunk, Detroit, Mich., J. N. LAUDER, Old Colony, Boston, Mass.

5.—"Buffers and Carrier Irons for the Master Car-Builders' Type of Coupler and a Standard Length of Draw-Bars." CHAS. F. SCHROYER, Chicago & Northwestern, Chicago, Ill. E. W. GRIEVES, Baltimore & Ohio, Baltimore, Md. E. B. WALL, Pittsburg, Cincinnati & St. Louis, Columbus, Ohio.

6.—"Car Heating and Lighting." (This Committee was instructed to select a steam coupler to be submitted to letter-ballot for adoption.) FRANK L. SHEPPARD, Pennsylvania Railroad, Altoona, Pa., R. D. WADE, Richmond & Danville, Washington, D. C., ROBT. MILLER, Michigan Central, Detroit, Mich.

7.—"Wheels."(This Committee was instructed to ascertain from the members of the Association whether the recommendations of their report would be acceptable to them, and from the replies received and the further experience which they may get during the coming year, to formulate a report, with recommendations, which can be submitted to the next meeting of the Association for letter-ballot, their recommendations to be adopted as a standard, if they meet the approval of the Association). J. N. BARR, Chicago, Milwaukee & St. Paul, Milwaukee, Wis., JOHN KIRBY, Lake Shore & Michigan Southern, Cleveland, O., GEORGE F. WILSON, Minneapolis & St. Louis, Minneapolis, Minn.

8.—"Standard Axle for 60,000 lbs. Car." (This Committee to report a form and the dimensions for such a standard axle at the next Convention). GODFREY W. RHODES, Chicago, Burlington & Quincy, Aurora, Ill., JOHN S. LENTZ, Lehigh Valley, Packerton, Pa., R. MCKENNA' Delaware, Lackawanna & Western, Scranton, Pa.

M. N. FORNEY, *Secretary.*

CONSTRUCTION NEWS.

RAILROADS.

East of Chicago.

Existing Roads.

South Norfolk.—Tracklaying is making good progress on this Canadian road, which is to run from Simcoe, Ont., on the Grand Trunk, to Port Rowan, on Lake Ontario, a distance of 17 miles. The construction train is now running to Forrestville, and will reach Port Rowan by Nov. 25.

Pittsburgh & Western.—It is announced that grading is to be pushed at once on the proposed extension of the Cleveland & Western Ry., from Carey O., east to Akron, known as the Pittsburg, Akron & Western. WM. SEMPLE, of Allegheny, Pa., is at the head of the enterprise, which is intended to furnish a short and favorable route for through traffic from Pittsburg west. The new line will run *via* Chicago Junction, and will reduce the distance between Pittsburg and Chicago over the Pittsburg & Western and Baltimore & Ohio lines about 25 miles. It is expected that the new route will draw so much traffic over the Pittsburg & Western, that a double track will have to be laid from Pittsburg to Akron. The Edgar Thomson Steel Works have the contract for the rails for the Pittsburg, Akron & Western.

New York & Massachusetts.—It is announced that this company has secured control of the Newburg, Dutchess & Connecticut Railroad, and also that work is to be "pushed" on the proposed extension from Boston Corners, N. Y., east to Springfield, Mass. If favorable grades and alignment can be secured for this extension, this is undoubtedly the natural route for traffic from the Poughkeepsie bridge eastward to New England, and the line just acquired will give close connections with the proposed Highland bridge across the Hudson at Peekskill. The New York & Massachusetts company, however, has thus far shown, judging from all appearances, far more energy in obstructing the work of its rivals than it has in building or preparing to build its own extension.

Pennsylvania, Poughkeepsie & New England.—Mr. JOHN S. WILSON of Philadelphia, has been chosen President of this company, which controls the Poughkeepsie Bridge, the Hartford & Connecticut Western R. R., and other lines under construction from the east and west terminals of the bridge. The Pennsylvania, Slatington & New England, which was partly built three years ago, will be given up by the company; and if finished, it will be as an independent line. W. W. GIBBS, of Philadelphia, whom Mr. WILSON succeeds in the Presidency, will retain control of the Slatington road, and it is rumored that he intends to push it to completion.

Flint & Pere Marquette.—This company has arranged for a consolidation of the Flint & Pere Marquette, the East Saginaw & St. Clair, the Saginaw County and the Manistee railroads, which will take effect May 15, 1889. These last named corporations are owned entirely by the Flint & Pere Marquette and are consolidated merely for the sake of getting the company's affairs into compact shape preparatory to building to Detroit.

Philadelphia & Reading.—A rumor has been afloat the past week that President AUSTIN CORBIN is planning to unite under one management, this system, the Long Island R. R., the Ohio, Indiana & Western, and possibly the Central Railroad of New Jersey and the Baltimore & Ohio systems. Little credence is given to the story, and it is probably based on no firmer foundation than the fact that Mr. CORBIN is now President of the first three companies.

Canadian Pacific.—Work on the new terminal station at Montreal has been retarded by the wet weather, but is now being rapidly pushed, and it is expected that the first train can enter the new station by Dec. 1, and the building will be ready for the use of passengers by Dec. 15.

Pittsburg, Shenango & Lake Erie.—Work has been resumed on the long delayed extension from Greenville, Pa., to Conneaut, O.

Pittsburg, Ft. Wayne & Chicago.—As a result of the recent inspection trip of the directors, it has been decided to expend next year nearly a million dollars in the inprovement of the terminals at Chicago.

Old Colony.—The 25th annual report of this company has been received. The gross earnings for the year were $6,322,628, and the expenses were $4,637,667. A 7 per cent. dividend was paid, and $74,361 was credited to improvement account. The equipment now consists of 210 locomotives, 477 passenger and baggage cars and 4,146 freight cars. Large additions to the passenger equipment will be necessary at an early day. During the year there have been laid 3,151 tons of steel rails and 315,000 sleepers; of the rails 898 tons were laid as guard-rails for bridges and on sidings. Fourteen new iron bridges have been erected, and four grade crossings have been discontinued at a cost

of $12,591. The report says: "It is a matter of delay and difficulty to induce towns to co-operate in this work; and so far as it has been done, the greater part of the expense has been borne by the company." The new steamboat *Puritan* for the Fall River line, is expected to be ready for service by May, 1889.

The most important event of the year was the lease effected of the Boston & Providence Railroad. The directors recommend the construction of the extension from Walpole to North Attleboro, and say that large expenditures must be made in the future for double tracking and the removal of grade crossings. They ask authority to apply to the Legislature for permission to increase their capital stock for this purpose. The report is accompanied by an excellent map of the system, something without which no report of a railroad company is complete.

New Projects and Surveys.

Schuylkill Junction.—This company has been chartered at Philadelphia to build a railway from 30th St., to 2d St., and Cheltenham Ave. The capital stock is $100,000. JAS. B. WASHINGTON is President. J. VAN ZANDT SMITH, THEODORE FROTHINGHAM, and THADDEUS L. VANDERSLICE of Philadelphia are among the stockholders. It is stated that the project is in the interest of the Baltimore & Ohio, which wishes to obtain close connections with the North Pennsylvania.

Ridgefield & New York.—The old New York, Danbury & Boston scheme pops up again under the above name, and some of our contemporaries devote considerable space to it. The proposed line is to run from Danbury, Ct., *via* Ridgefield, New Rochelle, Westchester, Port Morris, and Ward's and Randall's Islands. The road would cross to Manhattan Island at the foot of East 85th St. and continue down to a terminus at East 34th St. through an open cut. EDWARD BURDSALL of Port Chester is still at the head of the scheme and JOHN SCHUYLER is Chief Engineer. It is probable that considerable time will elapse, to say the least, before the enterprise is carried out.

Pittsburg, Cadiz & Ohio River.—This company has been organized at Zanesville O., with ALBERT E. BOONE, as President, and proposes to build a railway from the Pennsylvania State line in Columbia County, O., to McConnellsville. This is the fifth line of the some-time-to-be famous "Black Diamond" system, which has been projected. Thus far, however, the "system" has made a much larger showing on paper than anywhere else, and its projectors seem to prefer the work of incorporation to that of construction.

Dexter & Piscataquis.—Proposals are asked for building this line from Dexter to Dover, Me., a distance of 16 miles. Plans and specifications can be seen at the office of J. B. PEAKS, Dover, Me.

Tiffin & Fremont.—This company has been organized in Ohio, and proposes to build a railway from near Sandusky *via* Fremont to Tiffin on the Baltimore & Ohio, a distance of about 60 miles. The company has asked for local aid to the amount of $50,000 from Upper Sandusky, $30,000 and right of way through the city from Tiffin, and $25,000 and right of way from Fremont. J. SLOAN is the chief projector of the enterprise.

SOUTHERN

Existing Roads.

Atlantic & Danville.—Tracklayers on this Virginia road have reached the Brunswick county line, and it is expected that the road will be completed ready for traffic as far as Lawrenceville by Jan. 1.

Wilmington & Weldon.—It is probable that the Albemarle & Raleigh branch will be extended to Plymouth, N. C., *via* Jamesville, at an early day.

Savannah, Griffin & North Alabama.—This road is to be placed in a receiver's hands on petition of the minority stockholders. The majority of the securities of the company are held by the Central Railroad & Banking Co. of Georgia. The decision of the Court was that under the company's charter the Central R. R. & B. Co. could not own stock in the controlled company.

Central Railroad of Georgia.—In an interview with a reporter of the Atlanta *Constitution*, President E. P. ALEXANDER said:

"I have just returned from New York and have talked with the gentlemen who are at the head of the Terminal Co. There are no new developments in this matter, nor do I anticipate any. I do not look for any startling changes in the present management of southern railroads.

"As to the Eden extension, I think it will be built. It was considered a feasible project by the Georgia Co., and believe it will be completed by the Terminal Co. It is surveyed through a section of the State that will make it a paying line of road, and that is the main consideration.

Alabama Midland.—The contract for grading this road has been let to Jas. M. Brown & Co., of 145 Broadway, New York City, who will sublet the work. Location has been completed for the first 35 miles, and grading is to begin at once.

Chesapeake & Ohio.—The Maysville & Big Sandy is just receiving the finishing touches, and will be ready for through trains this month. Until the new bridge is finished, trains will run over the Louisville & Nashville bridge into the Little Miami depot.

Jacksonville, Tampa & Key West.—It is announced that this Florida company has secured control of the Florida Southern system, extending from Palatka to Trabue with branches, a total trackage of 308 miles. This makes the J. T. & K. W. system the largest as well as the most important in Florida.

New Projects and Surveys.

Cairo & Tennessee River.—This company was voted aid to the amount of $200,000 on Nov. 10 by Christian County, Ky. On the same day a subsidy of the same amount was voted by the county in aid of the Ohio Valley Ry. The press reports give glowing accounts of the enthusiasm which prevailed; an enthusiasm which will probably be remembered with curious sensations some day when the taxpayers are enthusiastically paying up the county's bonded indebtedness.

Owensboro, Falls of Rough & Green River.—It is stated that this Kentucky company has floated bonds to furnish funds for its proposed line and will begin grading in the spring. J. W. M. FIELD of Owensboro has the contract.

Virginia & Northwest.—This company has been chartered in West Virginia and proposes to build a railway from the mouth of Coal river in Kanawha county to Guyandotte Mountain in Boone County. L. KESSLER of St. Albans, W. Va., is interested.

Huntington & Guyandotte River.—Chief Engineer WILLIAM HARRY has completed surveys for this West Virginia Railroad from Logan C. H., to Pinesville, Wyoming county. J. L. CALDWELL of Huntington is President.

Birmingham, Powderly & Bessemer.—E. LESSER, JOSEPH BEITMAN and others of Birmingham, Ala., have incorporated this company to build a railroad to Bessemer, Ala. Surveys are to begin at once.

Scotsboro & Guntersville.—A preliminary survey is soon to be made of this proposed Alabama road. J. S. JORDAN of Scotsboro is interested.

THE NORTHWEST.

Existing Roads.

Northern Pacific & Manitoba.—The arrival of cold weather has ended the fight between this company and the Canadian Pacific. Orders have been given by the Provincial Government to discharge the forces now engaged in construction, and no further attempt will be made to complete the line till spring. To obviate any further trouble as to the crossing of the Canadian Pacific, and also enable the company to extend its line to the Souris coal fields and such other points outside the province boundary as it may desire, a charter for the company is to be obtained from the Dominion Parliament at its next session.

Duluth, Red Wing & Southern.—Tracklaying began this week on this Minnesota road, and it is expected to have the rails laid and trains running from Red Wing to Zumbrota by Dec. 15.

St. Louis, Alton & Springfield.—Tracklaying is in progress on the extension from Newbern to Alton, Ill., and will be completed by Dec 1.

Chicago, St. Paul & Kansas City.—It is reported that surveying parties working in the woods south of Superior, Wis., are in the employ of this company.

Cairo, Vincennes & Chicago.—This railway extends from Cairo, Ill., north to Tilton, a distance of 258 miles. It is proposed to build an extension to Forrest, on the Wabash Ry., which will give a line from Cairo to Chicago that can compete with the Illinois Central. It will also give an outlet for the local traffic of the Cairo, Vincennes & Chicago north to Chicago independent of the Chicago & Eastern Illinois.

Duluth & Winnipeg.—About 1,000 men are engaged on the construction of this road from Duluth north. An entrance to Duluth will be made for the present over the St. Paul & Duluth Railroad.

Chicago, Burlington & Quincy.—The directors have voted a quarterly dividend of one per cent., making 5 per cent. for the year. This is the smallest dividend which the company has paid since 1863, and it is extremely doubtful whether the net earnings for the current year have been large enough to warrant even this.

THE SOUTHWEST.

Existing Roads.

Texas & Pacific.

ST. JAMES, La., Nov. 6, 1888.

EDITOR ENGINEERING NEWS:

The Texas & Pacific R. R. has at last been taken out of the hands of the Receivers. Governor BROWN is retained as President. The road has been doing a good business and the prospects are better now than ever for an increase in traffic. The road has been transformed by the wise administration of affairs under the direction of Governor BROWN and Captain GRANT from a cow path, as it was when they took charge of it, to one of the best equipped and ballasted roads in the country. Their regular schedule is now 35 miles per hour, and they are capturing a good share of the California travel. Supt. PEARSALL has done a lion's share towards aiding in the good work of improvement. All restaurants, formerly kept on the soup house plan, have been turned over to J. D. WILLIS and after a thorough renovation have been placed on the list of the best in the South. All bridges and trestles have been renewed and over 5,000 piles driven within the last 12 months. They also have under construction a branch from Plaquemine, La., to Indian Village, which will give them a new line of traffic. Although the branch is only 10 miles long, it brings them to the head of navigation of a system of lakes and small rivers, which afford easy access to Bayou Teche; and it is the intention of the company to put on a line of boats to compete with the Morgan line for the Teche trade, of which the Morgan people have enjoyed a monopoly for years. They also contemplate building a branch at Alexandria, La., to be used as a timber road to develop the timber interests of the system. Altogether the Texas & Pacific R. R., has as healthy an appearance as any road in the country, and instead of being a drug on the market, Texas Pacific stock will be clamored for as eagerly as New York Central & Hudson River R.R. stock in the near future. W. I. WILLIS.

New Projects and Surveys.

Granite Mountain & Marble Falls City.—This company has been chartered at Marble Falls, Texas, by T. H. HOLLOWAY, GEO. PENN, W. H. WESTFALL and others, to build a branch from the Austin & Northwestern R. R. at Granite Mountain to Marble Falls, about 4 miles.

Williamsville, Greenville & Northeastern.—This Missouri road is under survey for a distance of 40 miles A. L. BOWEN of Williamsville is Chief Engineer.

ROCKY MOUNTAIN & PACIFIC.

Existing Roads.

Seattle, Lake Shore & Eastern.—An excursion took place over the completed portion of the line from Spokane Falls west on Nov. 4; the train ran from Spokane Falls west 11 miles to the end of track. It is expected to have the road completed to Wheatdale, 40 miles from Spokane Falls by Nov. 20. The company has thus far expended about $500,000 on the grading and bridges on this division.

Mexican International.—It is stated that this company will build a branch from Benito to Monterey on the Mexican National, to make connection with the proposed Monterey & Tampico Railway.

Mexican Railways.—The message of President DIAZ to the Mexican Congress, contains the following:

The progress made in the principal departments dependent upon the department of public works since my last message has been indeed noteworthy. With regard to railroads, despite the fact that rains have been copious in the greater part of the country, it can be stated that works of survey and construction have been begun on some lines, while on others such work has continued with little or no interruption. On May 21 last, the Central Railroad Company opened up to traffic the important line from Irapuato to Guadalajara, 259 kilometres in length. On the Tampico-San Luis branch the iron has reached kilometre No. 188, on the bank of the Gallinas river, over which it is proposed to throw a bridge for the tracks. The roadbed of the same has been prepared as far as kilometre 232. On the line from Aguascalientes to San Luis Potosi, the locomotive, on the 9th inst., arrived at Selinas del Venon, some 110 kilometres from Aguascalientes, and about half the distance from San Luis Potosi. The Mexican National Company has worked with great activity to complete the branch from Saltillo to San Miguel de Allende, in length 595 kilometres. At the close of this month the Northern line reached the city of San Luis, while the road is to be connected soon at the Boquillas viaduct, for it is to be opened for traffic in November. The conclusion of this great line, which unites cities of importance, will give a third road of steel to link the City of Mexico with the frontier of the United States. The Hidalgo Railroad Company has finished 5 kilometres, on the line from Tepa to Tulaucingo, as well as 20 to unite San Augustin and Teoloyucan, thus making another line to connect Pachuca with this capital, as well as with the Central and National railroads. Regarding the Interoceanic Railroad Company, formed by the fusion of various companies, it can be said that 20 kilometres have been terminated on the road from Yantepec to Amacusac, and 30 more on the section between Mazapa and San Martin Texmelucan. It is to be presumed that by the aid of the financial combinations recently effected in London this railroad will give great impulse to their labors. The companies in Yucatan are likewise engaged in construction. The Merida-Calkini branch has delivered 6 kilometres and the Merida-Valladolid 7. The total extent of railroads in the Republic reaches now 7,500 kilometres.

Oregon & Washington Territory.—Nearly 100 miles of track are laid on this road; from Stanton Junction to Centerville, 35 miles; from Stanton Junction to Fulton, 14 miles; from Wallula to Walla Walla, just being completed, 53 miles.

Southern Pacific.—Statistics of the earnings on the entire system, from January 1, to September 1, show a total of $29,947,634 gross earnings, as compared with $24,080,577 for the same period last year. The net earnings were $10,085,605, compared with $9,534,220 in 1887. Of these net earnings $8,165,669 came from the Pacific system alone. The Atlantic system net earnings were $1,919,934.

Union Pacific.—Surveys are reported in progress for a new route to Leadville, Col. by Musquito Gulch, with a to Canon City.

San Francisco & Northern Pacific.—Track laying is in progress on the Cloverdale & Ukiah extension and it is expected to finish it by the end of the year.

New Projects and Surveys.

Elk Mountain.—

COLO. SPRINGS, Col., Nov. 1, 1888.

EDITOR ENGINEERING NEWS:

The Elk Mountain Railway was chartered Nov. 30, 1887, and is to run from Carbondale, on the Denver & Rio Grande Railroad, up Crystal river (Rock creek) to Crystal, a distance of 33 miles. Work is moderate. The maximum grade is 3 per cent., maximum curve is 18°. The line is projected in the interest of the Pacific Coal & Coke Co. Its principal sources of traffic will be anthracite and bituminous coal, coke, marble, slate, iron and silver ores. Rights of way have been obtained on Government lands, and surveys are completed. THOS. H. WIGGLESWORTH is Chief Engineer.

ORLANDO METCALF, *President.*

Los Angeles, Utah & Atlantic.—This company has been incorporated at Los Angeles, Cal., with a capital stock of $10,000,000 to build a railway from San Pedro Bay to the eastern boundary of the State. Among the directors are J. M. C. MARBLE, of Van Wert, O., President of the Cincinnati, Jackson & Mackinaw R. R., and C. W. SCOTT, of Manistee, Mich.

Stockton, Fresno & Southern.— This California company proposes to build a railway from Stockton to Visalia, Cal., about 150 miles. The line will run through the San Joaquin Valley and will parallel the Southern Pacific at a distance of about 15 miles to the east. The company has filed a mortgage to the Union Trust Company of New York City, and claims to expect no trouble in floating its bonds. Eventually the line is to be extended to Oakland on the north and to Bakersfield on the south. Negotiations with contractors are now in progress. A. L. DAVIS, of the A. S. Hailadie Iron Works of San Francisco, is President of the company; A. T. EGGLESTON is Secretary and F. HOMER is Chief Engineer

Proposals Open.

Railway.—For the construction of the Dexter & Piscataquis R. R., from Dexter to Dover, Me., 16 miles. Plans, profiles and specifications on file at the office of J. B. PEAKS at Dover. JOSIAH B. MAYO, President, Dover Me.

Sewers.—Manholes, receiving basins, 10, 12, 13 and 15-in. vitrified salt glazed sewer pipe. ERNEST ADAM, City Surveyor, Newark, N. J. November 22.

Street Work.—Grading, flagging, cobblestone paving. JOHN P. ADAMS, Commissioner of City Works, Brooklyn, N. Y. November 22, 26.

Setting Lamp Posts.—Setting gas lamp posts. JOHN P. ADAMS, Commissioner of City Works, Brooklyn, N. Y. November 26.

GOVERNMENT WORK.

Dredging.—Channel in Gowanus bay, New York harbor; Shoal in Buttermilk channel, New York harbor; channel off Seguines Point, Raritan bay, N. J.; removing broken rock from Flood Rock, Hell Gate, N. Y. Capt. GEO. MCC. DERBY, U. S. Engineer Office, Army Building, New York City. November 21.

Dam.—For repairing old and building new rock and brush dams and shore protections: 1st, between Keokuk, Iowa, and LaGrange Mo., to the extent of the amount of $30,000 alloted to this portion of the river; 2d, between LaGrange and Hannibal, Mo., allotment $30,000; 3d, below Hannibal, Mo., by operating the U. S. S. Coal Bluff and barges, allotment $30,000. Capt. E. H. RUFFNER, U. S. Engineer Office, Quincy, Ill. November 29.

Dredging.—Excavating about 920,000 cu. yds., of material from Maumee bay, along the line of proposed straight channel for Toledo harbor, Ohio. Major L. COOPER OVERMAN, U. S. Engineer Office, Cleveland, O., December 5.

Dredging.—Channel at Mount Vernon, Va.; York river, Va.; Nomini creek, Va.; Breton bay, Md.; Patuxent river, Md. S. T. ABERT, U. S. Engineer Office, Washton, D. C. December 10.

Steel Forgings.—Supplying 25 sets of steel forgings, of American manufacture, for 3.2 in. guns. Brig. Gen. S. V. BENET, Chief of Ordnance, War Department, Washington, D. C. December 11.

Dredging.—Gravel, disintegrated rock and solid rock from the channel of the James river near Richmond, Va. Resident Engineer, C. P. E. BURGWYN, Richmond. Col. WM. P. CRAIGHILL, U. S. Engineer Office, Richmond, Va. December 10.

Breakwater.—Furnishing 6,367 cu. yds. of rubble stone 1,756 cu. yds. of large stone (1 to 3 tons weight), and constructing 175 lin. ft. of extension to the breakwater at Gordon's Landing, Lake Champlain, Vt. Major M. B. ADAMS, U. S. Engineer Office, Burlington, Vt. December 13.

Dredging.—In Bridgeport harbor, Conn.; in Stamford harbor, Conn.; in Norwalk river, Conn.; in Five-Mile River harbor, Conn. Lt. Col. D. C. HOUSTON, U. S. Engineer Office, Army Building, New York City. December 13.

Breakwater and Dike.—Extending breakwater in Greenport harbor, N. Y.; extending dike in New Haven harbor, Conn. Lt. Col. D. C. HOUSTON, U. S. Engineer Office, Army Building, New York City. December 13.

Contracting.

The Southern Bridge Co., of Avondale, Ala., will enlarge its works.

The Hart-Wood Switch Co. has been incorporated at Birmingham, Ala., with a capital stock of $100,000, to manufacture a patented switch and frog with an unbroken main line, and is operated from the engine cab, by means of a lever which raises or lowers a suitable bar on the pilot. President, J. A. MONTGOMERY; Secretary, J. F. HART.

Drainage.—***Fort Mackinac, Mich.***—The following proposals for sewerage and drainage have been received by Lieut. E. B. PRATT, Asst. Quartermaster, U. S. A.: Sproul & McGurrin, Grand Rapids, Mich., $10,395; Dickson & Johnston, Sault Ste. Marie, Mich., $10,512; Robert Dunn, Detroit, Mich., $11,577; Dry Dock Sheet Metal Works, Detroit, Mich., $14,000; Joseph L. Gearing, Detroit, Mich., $15,285.43. The contract was awarded to Sproul & McGurrin.

Bridges.—***Cincinnati, O.***—The following were the proposals received for the construction of the McMillan St. bridge over Hunt St.: Variety Iron Works Co., Cleveland, O., $11,588; Queen City Bridge Co., $11,971; King Iron Bridge & Mfg. Co., Cleveland, $12,433; Columbus Bridge Co., $13,000; Wrought Iron Bridge Co., $13,100; Bracket Bridge Co., $13,200; Indiana Bridge Co., $16,000. The contract was awarded to the Variety Iron Works Co.

Fort Benton, Mont.—The following proposals have been received by A. E. ROGERS, County Clerk: Milwaukee Bridge Co., Milwaukee, Wis.; two bridges complete, $9,333; approaches, $16.45 per lin. ft.; Smith Bridge Co., Toledo, O.: two bridges complete, $12,600. San Francisco Bridge Co., San Francisco, Cal.; two bridges complete. $10,400; approaches, $5 per lin. ft. Massillon Bridge Co, Massillon, O.; for both bridges complete, $9,631, $9,215 $8,949.

Paving Specifications.—***Houston, Tex.***—The following are the specifications for work on Washington St., prepared by the City Engineer:

"Before placing the prepared pavement, the street must be graded, all soft or springy places must be dug out, refilled with proper material, and rammed or rolled to the satisfaction of the City Engineer. Upon this prepared subgrade must then be placed 8-ins. of gravel, and the same rolled until compacted to a 6-in. bed; upon this bed shall be spread a coating of clean sand, 3 ins. deep, to receive the pavement proper. The pavement proper shall consist of good hard Texas rock of following dimensions, viz: 4 x 6 x 8 laid perpendicularly to the axis of the street from curb line to curb line, thoroughly breaking joints, and to be well rammed or rolled so as to become firmly imbedded in the sand; the finished work to be well covered with clean sand, swept back and forth over spaces until the same are well and solidly filled. Curbs to be of brick. All curb walls shall start below the bottom of the gutter, on a footing of two courses, the offsets made on the gutter side; wall to be 9 ins. at the top, with a filter of ¾-in. to the foot for every foot in height; all brick to be good quality, hard burnt, and to be laid in mortar, composed of fresh Austin lime and San Jacinto sand, properly mixed, and to have 1 barrel fresh Rosendale cement to every 5 barrels of made mortar; each brick to be well bedded, joints flush and struck, and every 3 courses a header; the top to be finished with the hardest brick on edge; gutters to be 18 ins. wide, laid with concave bottoms, using sound, whole brick, and breaking joints to be well bedded in mortar, composed of one part Portland cement and two parts San Jacinto sand, and when so laid shall receive a coating of cement in the proportion of 1 cement to 1 of sand, and not less than ¾-in. thick. The gutter wall will be of 3 x 10 red heart cypress plank, set on edge, nailed to a 3 x 5-in. cypress stake driven to solid ground, and set 5 ft. apart. When a stake refuses to drive, holes must be punched with a bar, and all split stakes must be removed. All lines, grades and measurements will be given by the City Engineer, and must be strictly adhered to.

Metal Markets.—***Structural Iron.***—Prices are about as follows: in Philadelphia, 2.05c. @ 2.10c, for bridge plate; 2c. @ 2.10c. for angles; 2.6c. @ 2.7c. for tees, and 3.3c, for beams and channels, iron or steel. Store prices are as follows in Chicago: angles, 2.35. @ 2.50c.; tees, 2.60c. @ 2.70c. beams, 3.80c. Mill orders are taken at the following rates, f. o. b. Chicago: Angles, 2.20c. @ 2.25c.; universal plates, 2.25c. @ 2.35c.; tees, 2.55c. @ 2.65c.; beams and channels, 3.40c. New York prices are: sheared plates, 2c. @ 2.1c.; universal mill plates, 2.1c. @ 2.2c.; angles, 2.1c. @ 2.15c.; tees, 2.5c. @ 2.6c., and channels and beams, 3.3c.

Railway Track Supplies.—Pittsburg, Pa. Prices remain unchanged. Spikes, 2.20c., 30 days, delivered; splice bars, 1.85c. @ 1.90c.; track bolts, 2.85c. with square, and 2.95c. with hexagon nuts. In New York there is an active business in spikes, 2.20 to 2.30, delivered.

Steel Rails.—New York, $27 @ $ 28. Pittsburg, $26.50 @ $27. The Allegheny Bessemer Steel Co. has an order for 1,000 tons for the N. Y. Central; this company's new mill will be started up in January. Most of the leading New England lines have purchased their 1889 requirements, and when the Pennsylvania order for 40,000 tons, now pending, is closed, the principal trunk lines will be supplied. The South has ordered to a considerable extent, so that soon the greater part of the regular yearly work for the Eastern mills will be closed.

Old Material.—No. 1 wrought scrap, $21, net ton; old car axles, $15: cast scrap, $15.50, gross; wrought turnings, $14.50; old car wheels, $20; old rails, $22.50 in New York to $25 at Pittsburg.

Wrought-Iron Pipe.—Pittsburg. Prices remain unchanged. Discounts on black butt-welded, 52½ %; on galvanized do., 45 %; on black lap-welded, 62½ %; on galvanized do., 52½ %; boiler tubes, 60 % off regular list. 2-in. tubing, 13c. per ft., net; 5½-in. casting, 40c, per ft. net. (Compiled from *Iron Age.*)

Water Supply and Well.—The Cook Well Co., of St. Louis, Mo., has been awarded the contract for furnishing an additional supply of water for the water-works companies at Ashland, Neb., and Mattoon, Ill. It has also a contract for one 7-in. tube well for the Little Rock Oil & Compress Co., at Little Rock, Ark.

Electric Lighting.—***Galveston, Tex.***—The City Council recently appointed a special committee to make investigations regarding the advisability of the city establishing a lighting plant of its own. The present contract with the Galveston Gas Co. expires next March, and that with the Brush Electric Light Co. in May. These two companies having consolidated now have a monopoly, and this movement on the part of the city is doubtless in anticipation of a raise in price when the present contract expires. It is probable that bids for lighting the streets and public buildings will be advertised for; and if reasonable ones are submitted, the work will be continued on the contract plan. WM. SELKIRK, City Auditor, is Secretary of the Special Lighting Committee.

Galops Canal.—The Department of Railways & Canals, Ottawa, Canada, has awarded the contract for deepening the Galops canal, on the St. Lawrence, as well as the construction of two new locks and an improved entrance at the lower or Iroquis end of the canal, to Capt. J. MURRAY of St. Catherines, Ont., and M. A. CLEVELAND, of Brockport, N. Y., at about $700,000. A Canadian paper says "The most amusing part of the business is that the Galops canal goes practically to an American, notwithstanding the protest of the government against permitting Yankees to tender for Canadian public works, while Canadians are not allowed to tender for works undertaken by the United States or any of the State governments. But then the American element is strong in the Canadian cabinet."

Dummy Line.—The Selma Dummy Line Co., of Selma, Ala., has issued $15,000 in 7 per cent. 10 year bonds. The money is for extending the line, making it 9 miles long The line is well equipped. The company has $25,000 stock, $15,000 bonds.

Sewerage System.—***Fresno, Cal.***—The following proposals have been received by W. B. DENNETT, City Clerk: Geo. D. Nagle; pipes and flumes complete, $74,431.89; engine house and well complete, $4,000; water supply, $500; disposal of sewage, $500; concrete, 40 cts. per cu. ft.; lumber, $30 per M.; brick in wall, $20 per M. W. J. Schmidt, pipes and flume, $61,158.87; concrete, 45 cts.; lumber, $33. G. D. Clark, disposal of sewage, $2,000. M. McDonald, pipes and flume, $69,917; engine house and well, $8,500; water supply, $3,200 per year for 5 years; disposal of sewage, $2,500 per year for 5 years; concrete, 35 cts.; lumber, $25; brick, $17; water pipes, $3,087. J. B. Murray, $66,597; concrete, 35 cts.; lumber, $20. Hobson, Wilkinson & Hobson, $67,786.10; concrete, 42 cts.; lumber, $28; brick, $27; gravel, $2 per cu. yd. J. J. Dunn, $50,655.60 without flume or flush tanks; engine house without well, $5,400; concrete, 52 cts.; lumber, $32. Wm. Osbourne, $82,870.60; concrete, 30 cts.; lumber, $26; brick, $25. California Sewer Pipe Co., $46,119.40; concrete, 50 cts.; lumber, $22. Alex. McBean, $67,267.20; concrete, 50 cts.; lumber, $32. J. Tonbey and L. F. Bassett, $59,905.05; concrete, 50 cts.; lumber, $30. J. K. Carpenter, $63,666.20; concrete, 42 cts.; lumber, $36. Harkins & Barr, $52,560.60; concrete, 30 cts.; lumber, $40. C. B. Williams, $70,977.30; concrete, 8 cts.; lumber, $27. Fresno Canal & Irrigation Co., water supply, $3,000 per year for 5 years; disposal of sewage, $2,000 per year for 5 years. H. P. Gregory & Co., pumping plant and 2 boilers, $4,100. Julian E. Cary, 95 cts. per ft. for 22-in. cement pipe instead of flume. Pacific Sewerage Co., proposes to establish and build and furnish apparatus to dispose of sewage for 10,000, 20,000 or 50,000 inhabitants as city may elect, to be determined by arbitration at the end of 5 years; percentage of purchase price to be paid when plan is adopted. The bid of the California Sewer Pipe Co. was accepted, and all other bids for sewer system rejected. Bids for water supply and disposal of sewage were continued for the present. The specifications were drawn by MILLER & TIELMAN

The work advertised was as follows; furnishing and laying complete, including excavating and back-filling, 7,940 ft. of 18-in. iron-stone pipe, 980 ft. of 16-in., 4,200 ft. of 14-in., 4,580 ft. of 12-in., 2,000 ft. of 10-in., 7,520 ft. of 8-in., 37,250 ft. of 6-in.; 50 double and 1,544 single Y branches, 38 curved junctions (⅙ curve); 14 reducers from 8 to 16 ins., 46 T branches. Furnishing all material and constructing 46 lamp holes, 34 manholes, 8 flushing tanks; Wooden flumes 2 x 3 ft., 3⅝ miles, covered, constructed of 1¼-in. selected redwood, with about 15,000 yds. of excavation and back-filling. One brick reservoir, per 1,000 brick laid in walls, 6 ft. at bottom and 3 ft. at top, 8 ins. thick, brick lining on bottom; laid in best Portland cement, and coated with ½-in. coat of cement over entire area of interior, side and bottom; covered with plank on top. Also, for supplying not less than 2 cu. ft. per second of water for flushing purposes; if by wells, then, one 12-in. well, 20 ft. deep, with casing complete; 7,450 ft. of water service pipe; two pumps with 2 steel boilers and engines, all complete, capacity of each 1,500 galls. per minute, set in place, with engine-house. Also, for final disposition of sewage matter from lower end of wooden flume. Work to be commenced within 30 days from signing of contract, and completed by July 1, 1889.

The Costa Rica Development Co. has been incorporated at San Francisco, Cal., by HERMAN W. WIELAND, E. J. SABLA, E. C. GAERTNER and others; capital stock, $500,000.

Water Motors.—T. W. DEXTER, of Brunswick, Ga., wishes to correspond with manufacturers of water motors which will take water from an artesian well with a pressure of 22 lbs.

Canal Lock.—JAMES SHANAHAN, Superintendent of Public Works, at Albany, N. Y., has awarded the contract for rebuilding lock No. 60 on the Black River canal to Thomas H. Stryker, of Rome, N. Y., at $13,891.50. The only other bid was from Joseph A. Kellogg, of Sandy Hill, N. Y., at $16,491.50.

The Hughes Steam Pump Co., of Cleveland, O., has been awarded the contract for all of the pumps, 5 in number, for the new "Pioneer Press" building in St. Paul, Minn. One of the pumps is of the compound duplex type, and the others are high pressure duplex pumps.

Water Pipe.—The Board of Public Works, of Nashville, Tenn., have awarded the contract for furnishing 2,600 tons of 36-in. water main to the Addyston Pipe & Steel Co., of Cincinnati, O., at $22.44 per ton; special castings, $44 per ton.

Irrigation Canal.—The Dolores Number Two Land & Canal Co., of Dolores, Col., opened proposals Oct. 15, for the enlargement of a cut on the line of its main canal 5 miles west of Dolores, and awarded the contract to Geo. Bell & Co., of Pueblo, Col., at 80 cts. per cu. yd. without classification; the bids ranged from 38.5 cts. to $2 per cu. yd., without classification. The present excavation is 4,000 ft. long, 10 ft. wide on bottom, slope of sides as cross sectioned ¼ : 1; greatest depth 40 ft., surface of ground level laterally. The proposed enlargement is to bring the slope of the sides to 1 : 1; and the estimated quantity of material to be removed is 49,000 cu. yds. being about 27,000 cu. yds. of earth, and about 22,000 cu. yds. of rock, the latter consisting of a hard shale. The work is to be completed by not later than March 20, 1889. S. W. CARPENTER is General Manager.

Levees.—The following proposals for levee work in Yazoo, Mississippi Delta Levee District, were opened Nov. 3, by Capt. SMITH S. LEACH, U. S. Engineer Office, Memphis, Tenn.: Franklin & Vance; Webb-Hoop levee, 19 cts. per cu. yd.; felling timber, $35 per acre; grubbing, $75 per acre. J. S. McTighe, I. L. McKee and T. Sullivan, 17 cts. per cu. yd. for earthwork, $30 for felling, $100 for grubbing, 1 ct. per yd. for sodding; Ernest Hyner, 15 cts. per cu. yd. for earthwork, $60 for felling, $100 for grubbing, 1¼ ct. for sodding; W. O. Flynn and C. F. DeGaris, 15½, 15¾, 16 and 17 cts. for earthwork, $20 for felling, $125 for grubbing, sodding free; J. J. Coony, 16, 16⅛ and 17 cts. for earthwork, $50, $50, 1 ct.; F. S. Aderholdt, 15⅛, 15⅞, 16¼ and 16⅞ cts. for earthwork, $30, $125, ¾ ct.; P. F. Lamb, 15¾ and 17 cts., $25, $75, 1 ct.; J. K. Jeffries, 15½ and 18¾ cts., $15, $50, 1 ct.; D. T. Hartnett, 14, 16 and, 17 cts., $25 to $30, $50 to $100, 1ct.; A. A. Arnold and A. M. McDonald, 15½ to 17½ cts., $25 to $30, $40, ¾ ct.; J. R. Cook, 15 and 17 cts., $20, $60 to $75, ¾ to 1 ct. Contracts were awarded as follows: Webb-Hoop levee, J. R. Cook, 15 cts. per cu. yd.; Sections 22, 23, 24, McDonnell and Flynn, 16⅞, 17¼, 15¼ cts.; Section 25, J. K. Jeffries, 15½ cts.; Sections 26, 27, D. T. Hartnett, 14 cts.

Water-Works.—*Greenville, Tex.*—The following proposals were opened Nov. 1 by CHAS. H. LEDLIE, M. Am. Soc. C. E., of St. Louis, Mo., Chief Engineer of the Greenville Water & Electric Light Co.: *Hydrants and Valves*, Coffin Valve Co. (not in accordance with specifications); $2,115; Bourbon Copper & Brass Works, Cincinnati, $2,170, or $3,636.50 with frost case; Western Brass Mfg. Co., $2,295; L. M. Rumsey & Co., $2,475; National Tube Works, $2,500; Scovel & Irwin Construction Co. (Bourbon make), $2,600. The contract was awarded to the National Tube Works.——*Filters*; American Filter Co., (2) $5,000; National Water Purifying Co., (2) $5,500; Pond Engineering Co., (Hyatt, 4) $11,342. The contract was awarded to the American Filter Co.

Pumps and Boilers; H. R. Worthington, 10 x 8 x 10 x 18 ins., 35,000,000 duty, with boilers, $14,700; Knowles Steam Pump Co., 10 x 19 x 10¼ x 24 ins., 50,000,000 to 60,000,000 duty, independent condenser, boilers, $15,500; Deane Steam Pump Co., 10 x 20 x 10 x 18 ins., 50,000,000 duty, independent condenser, boilers, $14,275; Gordon Pump Co., (1) 11 x 20 x 10¼ x 18 ins., 60,000,000 duty, vertical condenser, $14,100; (2) same size, 55,000,000 duty, horizontal condenser, $13,300; Murphy smokeless furnace fitted to the horizontal boilers, $1,400 extra; with Babcock & Wilcox boilers, $15,900 for (1) and $15,000 for (2); Pond Engineering Co., for Holly Mfg. Co., 10 x 16 x 9¾ x 12 ins., 45,000,000 duty, $12,224; 12 x 18 x 10 x 18 ins., 45,000,000 duty, $14,557; Pond Engineering Co., for Volker & Felthousen Mfg. Co., 12 x 18½ x 10¼ x 12 ins., 45,000,000 duty, $11,088; 12 x 18½ x 10¼ x 18 ins., same duty, $14,657; Pond Engineering Co. and Shickle, Harrison & Howard Iron Co., 12 x 18½ x 10¼ x 18 ins., 45,000,000 duty, $13,500; Heine Safety Boiler Co., everything in boiler room complete, including boiler feeder, $5,098; Shickle, Harrison & Howard Iron Co., same bid, $4,500; John O'Brien, boilers and fixtures, $2,185. The contract was let on the bid of the Pond Engineering Co. and the Shickle, Harrison & Howard Iron Co., of St. Louis.

WATER.

Water Filtering.—The town of Richfield Springs, N. Y., has adopted the Hyatt system of water purification, and will have the plant in operation before next spring.

The Columbia Heights Water, Gas & Oil Co. has been incorporated at Denver, Col., by E. H. MARTIN, B. M. WILSON and T. P. WORMLEY, to sink wells for water, gas or oil. Capital stock, $30,000. The office will be at Pueblo, Col.

Phillipsburg, N. J.—The report of CARROL PH. BASSETT, C. E., made in September last on the sewerage of Phillipsburg, N. J., has been published in pamphlet form, and it is expected that an agitation of the mattor this winter will result in a part, if not the whole, of the system being built in the spring. Some attempts have been made to carry the storm water of some sections for short distances by culverts into the water courses, but in the more thickly settled parts of the city the need of sewers is urgent, as deep cesspools, maintained with open walls in the gravelly subsoil, are principally used for house sewage, and the dangers of such an unsanitary condition of affairs are evident. The topography of the city is described. The sewers carrying storm water and house sewage should be of brick, with a split pipe invert embedded in concrete, the sewers carrying storm water only should be of brick work throughout. According to the estimate submitted the storm and combined sewers are to be of brick 4 ft. × 6 ft. at $8, 40 ins. × 60 ins., at $6.50, and 36 ins. × 42 ins. at $6; 18-in. iron pipe at $2.25; 12-in. vitrified pipe at 90 cts., 15-in. at $1 and $1.10, 18-in. at $1.25, and 20-in at $1.50; the total being 20,040 ft., costing $51,744.50. The house sewer estimate is as follows:

250 ft. of 12-in. pipe	at	$ 0.90	$ 225.00
18,815 ft. of 8-in.	"	0.65	12,229.75
27,600 ft. of 6-in.	"	0.55	15,180.00
34 flush tanks	"	50.00	1,700.00
160 manholes	"	35.00	5,600.00
46,665 ft.			$34,934.75
Combined, 20,040 ft.			$51,744.50
Separate, 46,665 ft.			34,934.75
Total			$86,679.25

At the end of the report is given in full the text of the Act authorizing incorporated towns to construct sewers and drains, and to provide for the payment of the cost thereof.

Sewerage.—*Rochester, N. Y.*—The Genesee Valley canal outlet sewer has been completed at a cost of $44,600. The sewer is of stone, 36 ins.×51 ins., and is 7,100 ft. long. The Schanck Ave. sewer, also finished, is 4,200 ft. long, it is partly stone and partly pipe and cost $19,000.

Philadelphia, Pa.—The Survey Bureau, in its estimated appropriation for 1889, asks for $250,000 for the Aramingo canal sewerage system; $30,000 for additional work on the intercepting sewer, and $300,000 for new main sewers.

Charleston, S. C.—Pipe sewers are to be laid and the Street Department has been authorized to spend $10,000 in advance of the appropriation for 1889; bids for pipe have already been received. The work will be in the upper wards, the streets of which are now dependent upon surface drains.

Brunswick, Ga.—A sewerage system is projected.

Athens, Ga.—A vote is to be taken on a proposition to construct a system of sewerage.

Savannah, Ga.—Col. W. J. WINN, City Engineer, has been visiting several cities to study their drainage and sewerage systems, as it is proposed to establish a system at Savannah.

Helena, Mont.—Owing to trouble over the first set of bids received, the sewerage bonds have been readvertised.

Fort Smith, Ark.—By Nov. 8, about 8 miles of the sewer system had been completed. W. A. Doyle, the contractor, has till June, 1889, to complete the system of about 23 miles, and is now working with about 225 men. JAMES P. BATES is the engineer.

Lake View, Ill., Water Tunnel.—About six weeks ago, the City Council of Lake View, Ill., directed Mayor BOLDENWECK to prepare plans and estimates for a water tunnel extending eastward into Lake Michigan, with suitable shafts, cribs and inlets. Plans have been prepared by SAMUEL G. ARTINGSTALL, C. E., of Chicago, and sent to the Mayor; they provide for a brick tunnel 6 ft. diameter, extending into Lake Michigan 6,000 ft., where the water is 25 ft. deep; at the eastern end is a protection to the inlet, built in concrete and stone masonry, 75 ft. diameter and extending 15 ft. above water level, with an interior well 30 ft. diameter; there are four openings 4 ft. square, located near the bottom of the protection and connecting the lake with the well. The shaft of the tunnel ends at the bottom of this well. The protection is surmounted with a light-house built of wrought-iron with the center of light 80 ft. above water; the light is to be a cluster of incandescent lights operated by dynamos and engines located in the water-works buildings on shore and connected by a cable laid in the tunnel. The engineer's estimate is as follows:

Tunnel shafts and connections	$136,000
Lake protection	60,000
Light house	8,500
Incidentals	20,000
	$224,500

Water-Works.—*New Hampshire.*—Dover. The upper receiving well for the water-works is nearly completed.

Massachusetts.—Athol.—The water committee has decided to renew the effort to get the right to use water from Phillipston pond.——Mansfield. A new boiler house and two water tanks are being built near the depot. The tanks will hold 75,000 galls. and will be supplied by the water-works.——North Adams. The report of the committee on water supply has been accepted and it has been voted to have the proposed course for the 7 miles of pipe surveyed and an estimate made of the cost of the work.

New York.—Sandy Hill. Water was let into the distributing reservoir on Nov. 3.——Whitestone. A water supply is proposed; probably the system of College Point and Flushing will be extended to this place.——Jamestown. The water company is putting down two new wells at Levant, to be used for a reserve.——Amsterdam. The water main across the river has been completed and water supplied to the 5th ward.

Pennsylvania.—Allegheny. The Water Committee has notified the Health Committee that it will co-operate with it in the matter of the removal of the dead ends of water mains, which it is claimed are responsible for considerable sickness.

Maryland.—Baltimore. At a recent meeting of the Water Board, Registrar SHRIVER reported that collections for October amounted to $59,502.40, and that six months interest on the water loan, amounting to $244,315 had been paid. Chief Engineer MARTIN reported that there were laid 5,104 ft. of distributing main pipe of sizes ranging from 2 to 10 ins., which will yield an annual revenue of $2,257.50. Five fire-plugs and two fountains were erected.

District of Columbia.—Washington. The District Commissioners have directed that a 30-in. supply main be put down for the U St. pumping station, extending 282 ft. to connect with the present mains and with the new pumping engine. The cost is estimated at $1,045.74.

Tennessee.—Nashville. The water-works, reservoir, filters, etc., are said to represent an invested capital of $1,210,000.——Chattanooga. The water company has increased its capital stock to $800,000.——Cleveland. Water-works are projected; address JOHN H. CRAIGMILES.

Kentucky.—Georgetown. Water-works are projected.

South Carolina.—Anderson. The Anderson Hotel Co. proposes to establish a private water supply.—Winnsboro. Water-works are projected. Address JAS. G. DAVIS, or the editor of the *News & Herald*.

Alabama.—Anniston. A franchise for water-works has been granted to T. G. BUSH and others; the supply will be taken from springs. The works will be commenced at once and will cost about $150,000.—Attala. Water-works are needed.——Marion. The corporation authorities contemplate building water-works.

Mississippi.—Greenville. The water company is pushing construction, and the locations of the hydrants have been marked out by City Engineer O'Hea.

Iowa.—Silver City. There is talk of establishing water-works. The matter has been brought up in council but no action has been taken.

Dakota.—Sioux Falls. There is talk of another water-works system. A quarryman named DRAKE has found a stream of water issuing from the rocks which flows from 25,000 to 30,000 galls. per day, which he imagines is, or ought to be, sufficient to supply the city, and he is trying to enlist capital in his enterprise. As the present company is pumping about 500,000 galls. per day, the prospects for this new scheme are not very bright.

Kansas.—Argentine. The National Water-Works Co., of Kansas City, Mo., will probably get a franchise to furnish the city with Missouri river water.

Missouri.—St. Louis. E. C. ROBBINS, a well-borer of the city, has secured a contract for boring a well at Jennings Heights, from which the water supply of that locality is to be obtained.——Washington. The water company has completed its connection with the river and pumphouse; the pump is run 36 ft. out in the river, below low water mark. There was considerable difficulty in connecting the mains, on account of the quicksand which had to be removed; the difficulty was finally overcome by the construction of two breakwaters, when the sand and water were easily removed from the trenches.

Colorado.—Silverton. The Silverton Water Supply Co. has been incorporated to buy out the Silverton Water-Works & Supply Co. The principal office is at Longmont, Col., with branch offices at Worcester and Springfield, Mass. Capital stock, $50,000. BYRON L. CARR, CONRAD BARDELL and F. P. SECOR are interested.

Canada.—Montreal. At a recent meeting of the Water Committee, an estimate of the cost of the land required for the new aqueduct, prepared by M. MCCONNELL, Assistant Superintendent, was laid before the meeting. The amount for property expropriated is $104,000; cost of surveying, $25,000, making a total cost of $130,000. It was resolved to ask Council for an appropriation of that amount. The experts reported that the Heine boilers had been subjected to another test with satisfactory results. It was agreed to accept the boilers provided they were put in the same condition as the one tested.

Brooklyn, N. Y.—Mayor CHAPIN has approved the resolutions passed by the Common Council granting a franchise to the Edison Electric Illuminating Co.

Winona, Minn.—J. B. FELLOWS, Water Commissioner, has made a report to the Council in regard to the efficiency and management of the city's system of water-works. There are 4 boilers, and 2 pumping engines; the engine of 2,000,000 galls. daily capacity is in continual use, and the 3,000,000 galls. engine is used for reserve and in case of fire. The water in the well is about 5 ft. deep, but the well is gradually filling with fine sand. The ordinary pressure is about 40 to 60 lbs., and 90 lbs. for fire purposes. The water supply, however, is inadequate. The new water-works well is to be covered in, and plans and specifications for this work have been prepared by the city engineer.

Drainage in Illinois.—The Monticello drainage district scheme was organized Sept. 18, 1882, and SAMUEL L. BUSICK, ANTHONY CLARK and CLARK, M. BURGESS were elected Commissioners, with A. L. RODGERS as Clerk. The original district was organized as a Piatt Co. Drainage District to reclaim a large body of land in the Eastern portion of the county. The first regular report was made Oct. 30, 1885, which showed that commencing at the northeast line of Piatt Co. they had made 5½ miles of ditch. The first mile was 20 ft. wide at the top, 6 ft. wide at the bottom, and 7 ft. deep; the second mile 25 ft. wide, and the remainder 30 ft. The second report, made Oct. 30, 1886, showed that 7 additional miles had been made, 2 miles being 35 ft. wide at the top and 8 ft. at the bottom and the rest 40 ft. wide at the top, 15 ft. at the bottom, and 7 ft. deep. They had also made 7,000 ft. of laterals. Their report of October, 1887, showed that 3½ miles had been added to the main ditch, which was 40 ft. wide at top, 15 ft. at bottom, and 7 ft. deep, making the main ditch 16 miles long. The cost was $78,000, which was raised by assessments upon the land in the drainage district. There are also 31 lateral ditches, which, when all are completed, will cost $100,000. The total cost will amount to $200,000 and it is one of the best investments ever made, as thousands of acres of land in the counties of Champaign, Piatt, and Douglas have been reclaimed. The drainage district contains, 42,000 acres of good land. Besides the ditches described, many miles of large tile ditches have been put in by the Commissioners. The district embraces 65 sections, most of it in Piatt Co., and up to the time of the organization of this drainage district thousands of acres were untillable. Owing to the overflow which occurs every year just at crop time the new channel formed is washing out. When it is made wider at the bottom, which will be done, it will wash out much more readily, and at no distant day there will be a continual flowing stream fed by hundreds of other smaller ditches. A heavy rainfall now causes the overflow of the ditch, but this cannot happen when it is enlarged. The contractors for the work are Pollard & Goff.

Rochester, N. Y.—A party of citizens made a trip last week to Mt. Morris and Portageville, on the invitation of the water storage committee of the chamber of commerce. It was designed as a tour of investigation that the members of the committee and their guests might have an opportunity of making a personal inspection of the ground where it is proposed to construct a high dam for storing the waters of the Genesee for use in the dry season, and of the great natural basin behind the site of the proposed dam that, if the project is to be carried out, will be turned into a grand reservoir. At St. Helena the water would be about 25 ft. deep, covering the flats. The land on the site of the reservoir is mostly poor and comparatively worthless. The reservoir will be 11 miles long and 1,000 to 4,000 ft. wide. One scheme is for 3 separate dams one low one to be constructed first and the others as they might be needed, an appropriation of about $12,000 to be first made by the city for preliminary surveys. But the scheme of a single high dam near Mt. Morris is generally approved. Among the party were J. NELSON TUBBS, C. E., and EMIL KUICHLING, C. E.

Allegheny, Pa.—At the Council meeting on Nov. 8 the resolution awarding the contract for an electric light plant to the Jenney Company, of Indianapolis, for $111,725, as passed in Common Council, was called up and discussed at some length, and eventually a resolution was adopted providing that the matter should be sent back to the committee with instructions to readvertise for bids on the rental basis, the city to have the right to purchase the plant at a fixed price, less the wear and tear; the wear and tear to be decided by three experts, one of whom the city should name, another the company, and the third by these two. Mr. LARE, in support of his motion, said that the rental system was the more business-like. The city did not risk a large sum of money in a business of which it knew nothing, but learned the business first and then made the investment. It would be cheaper to rent than to buy a plant. He had been assured by three electricians that it would cost over $2,000 a year to run the plant, and would require a number of new offices, which he didn't think the people would like.

Rosario, Argentine Republic.—The Rosario City Improvement Co. has been incorporated in England, with a capital stock of $2,250,000, for the purpose of constructing a complete system of drainage and sewerage works under a concession granted by the municipality. The city is in the province of Santa Fè and is the second largest city in the republic, having an estimated population of 70,000. It has an excellent system of water-works, and arrangements have been made with the water company for flushing the sewers. The use of the drainage system is compulsory, and the rates are 20 cts. per month for every lineal metre of frontage. The concession is for 70 years, after which period the works revert to the municipality; but after 20 years the municipality may acquire the work on terms stated in the concession. The revenue is estimated at $250,000 per annum, the debenture interest is $135,000, leaving $115,000 a year for working expenses (estimated at $50,000) and dividend. The works were designed by the company's engineer, J. F. W. FEATHERSTONHAUGH, C. E., and were accepted by the municipality after all the tenders had been referred to Mr. W. WHITE, late President of the Council of Engineers of the Argentine Government, for examination. The plans, etc., were also examined and approved by Mr. S. ABBOTT, C. E., of the Great Southern Railway of Buenos Ayres, and have since been submitted to Sir JOSEPH BAZALGETTE, C. E., whose report on the scheme is very favorable. John G. Meigs & Co. have taken the contract for construction; the first section will be completed in about 15 months, and the entire works are to be completed by Oct. 1, 1891.

Special Reports of Water-Works Construction.

THE ENGINEERING NEWS MANUAL OF AMERICAN WATER-WORKS is now being compiled, and will be *indispensable* to every manufacturer, engineer and contractor in any way interested in Water-Works construction and maintenance, and will be of great value to Water-Works superintendents and projectors of new works.

Superintendents of water-works and water companies will wish to see correct and complete data concerning their Works in our MANUAL, and to ensure this they should send in reports *at once* upon the blanks which we have already sent to every Water-Works office in the United States and Canada. Many have delayed their report, and if the blanks we intended for them have been lost in the mail, or mislaid, we will send more upon request.

We *must* have a report from every public water supply system in North America, so those who reply to our inquiries at once will save a second inquiry. We also wish to know of *every* new Water-Works plant in process of construction, and of *every* new project in this line. We will send to any one desiring them, blanks upon which reports can be made.

Further details of the MANUAL will be advertised later. We abstract from our special reports for the MANUAL the following items of current interest:

HINTON, W. Va., Nov. 3, 1888.

EDITOR ENGINEERING NEWS:—Our population is 1,600, and our present water supply is from wells and cisterns, and by hauling from river. Water-works, costing $20,000 are proposed, and the town has voted $10,000 for this purpose. Water will be pumped from New river to reservoir. Nothing more definite has been decided.

J. PRINCE.

GOLDSBORO, N. C., Nov. 12, 1888.

EDITOR ENGINEERING NEWS:—Some time ago the city awarded a contract and granted a franchise to a party for water-works. The party did not comply with the agreement, and we are still waiting on them. We want water-works, and must have them of some kind.

F. H. BAIN, *City Clerk.*

A previous letter states that the works for Goldsboro were estimated to cost $75,000; water to be pumped from Little river, about one mile distant, to a stand-pipe.

LA GRANGE, Ga., Nov. 3, 1888.

EDITOR ENGINEERING NEWS:—We need water-works, and an effort was made several months since to establish them. Address H. E. WARE, Mayor, or Dr. F. M. RIDLEY.

P. M.

TITUSVILLE, Fla., Nov. 6, 1888.

EDITOR ENGINEERING NEWS:—The town is having an artesian well bored. For particulars address H. F. ATKINSON.

J. E. GUEBER.

CALERA, Ala., Nov. 7, 1888.

EDITOR ENGINEERING NEWS:—The Calera Land Co. has an artesian well with a flow of 500 galls. a minute, and a reservoir, and it is proposed to organize the Calera Water Co., sink another well, and put in works at a cost of $50,000.

J. R. ADAMS.

UNIONTOWN, Ala., Nov. 5, 1888.

EDITOR ENGINEERING NEWS:—The village proposes to build water-works at a cost of $4,000 or $5,000, taking the supply from bored well. Contracts will be let about Nov. 13 or 20. M. L. ERNST is chairman of Water Board.

J. C. WELSH.

RICHMOND, Ky., Nov. 3, 1888.

EDITOR ENGINEERING NEWS:—We have a charter for water-works, and the prospects for building them are good. Address F. H. ADAIR.

P. M.

PULASKI, Tenn., Nov. 3, 1888.

EDITOR ENGINEERING NEWS:—Water-works were voted several months ago for this place, but nothing further has yet been done.

H. C. MCLOUBINE.

PARK RIDGE, Ill., Nov. 6, 1888.

EDITOR ENGINEERING NEWS:—In '75-6 the corporation Trustees sunk a well a little over 1,500 ft., tubed for 200 ft. with 6-in. pipe, and for 600 ft. with 3¼-in. The well first gave a flow 10 ft. above the surface, but it was soon stopped up to prevent waste, and since water has remained 8 ft. below the surface. An ordinary pump was attached to the well and nothing more done until two years ago, when a thorough test was made, and after trying to get some company to contract to give us a flow 30 ft. above the surface for 30 years, it was agreed to erect an 800 barrel iron tank on a brick foundation 24 ft. high, and pump water to it for distribution. Wyckoff wood pipe of 4 and 6-in. diam. was laid, the only iron pipe being between the well and tank. The first pump, a Worthington, has proved insufficient, and will have to be replaced by a larger one. We are now receiving bids for 1,400 ft. of Wyckoff wood pipe. The well gives an ample supply.

The well cost $10,000, $5,000 of which was met by 10 per cent. bonds. These have been paid and our only debt is $2,500 of bonds lately issued. The works are not yet quite self-supporting, but will be in one year more.

SAM'L. COCHRAN, *Sec. of Water Com.*

In addition to the above we learn from GEO. C. MORGAN, Chicago, that he was engineer and contractor for the work done in '87, and that he used Morgan hydrants. He says the pump is a 150,000 galls. Deane, and that there are 1½ miles of pipe.

ARGENTINE, Kan., Nov. 3, 1888.

EDITOR ENGINEERING NEWS:—We are trying to contract with the National Water-Works Co., of Kansas City, for a supply. Our population is 5,000.

G. W. GULLEY, *Mayor.*

NESS CITY, Kan., Nov. 4, 1888.

EDITOR ENGINEERING NEWS:—Bonds for water-works have been voted by the city. Address ROSS CALHOUN, Mayor.

SOUTH DENVER, Col., Nov. 3, 1888.

EDITOR ENGINEERING NEWS:—The town has voted to issue $160,000 of bonds for water-works. Water will be taken by percolation from the Platte river, then pumped direct, and to stand-pipe. The valuation of town property is $1,500,000. Contracts will be let in 60 days, works begun in 90 days, and finished next June. Our present supply is from artesian wells, and our population is 1,500.

JAS. A. FLEMING, *Mayor*, Box 2,019 Denver, Col.

RECORD OF NEW WATER-WORKS CONSTRUCTION.

(Specially Communicated).

CONTINUED FROM PAGE 378.

Hummelstown, Pa.—The works were commenced in April, 1888, and have been in operation since August, 1888. They were designed by RAYMOND & CAMPBELL, of Middletown, Pa., who also took the contract for construction; the buildings were erected by JAS. H. GROVER, of Middletown, Pa. The supply is taken from Swatara creek and pumped to a stand-pipe 100 ft. high and 16 ft. in diameter by a pump of Raymond & Campbell's make. There are 2⅕ miles of 4, 6 and 8-in. pipe, 22 hydrants and 75 taps. Ordinary pressure, 75 lbs; fire pressure, 150 lbs. Cost of works, $50,000 (including new roller flour mill.) Debt, $5,000, besides bonds and stock; rate of interest, 6 per cent. Annual revenue, $600 from consumers, $600 from city, $1,500 from mill. The water company owns a roller process mill, capacity 55 barrels per day, worth $2,000; it is rented for $1,500, which will be increased after April 1890 when the lease expires; the mill was built by the company and has a good trade. It takes about 3 hours pumping per day to supply consumers. The works are owned by the Hummelstown Water Co.; President, F. J. SCHAFFER; Secretary, W. H. SIPLE; Treasurer, J. S. STRICKLES. Capital stock, $22,500; bonds, $22,500. The charter is perpetual. SIMON CAMPBELL is Superintendent. The present population is 1,600. (Date of special report; October 12, 1888).

Stevens Point, Wis.—The works were commenced in March, 1887, and completed July 1, 1888. They were designed by JOHN HOLMES, of New York, who was also Constructing Engineer. The contract for construction was taken by Samuel R. Bullock, of New York City; the pumping machinery was supplied by the Holly Mfg. Co., of Lockport, N. Y.; the hydrants and valves by the Holyoke Hydrant & Iron Works, of Holyoke, Mass.; the pipe and specials by the Florence Iron Works, of Philadelphia, Pa.; and the stand-pipe by Tippett & Wood, of Phillipsburg, N. J. The supply is taken from the Wisconsin river, and pumped to a stand-pipe 120 ft. high and 20 ft. diameter by 2 compound condensing pumping engines with a daily capacity of 4,000,000 galls. There are 10½ miles of pipe, and 110 hydrants; the mains are of cast-iron, and the service pipes of wrought-iron and lead. Rate of interest, 6 per cent. Annual revenue from the city, $5,000. The franchise is for 20 years. The works are owned by the Stevens Point Water Co.; President, E. WOLTMANN; Treasurer, J. C. BERTINE; Secretary, N. P. HOBART; Superintendent, W. O. LAMOREUX. Stock, $175,000; bonds, $175,000. The present population is 10,000.

(TO BE CONTINUED.)